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AN EVALUATION OF THE UTILIZATION OF REMOTE SENSING IN RESOURCE AND ENVIRONMENTAL MANAGEMENT OF THE CHESAPEAKE BAY REGION

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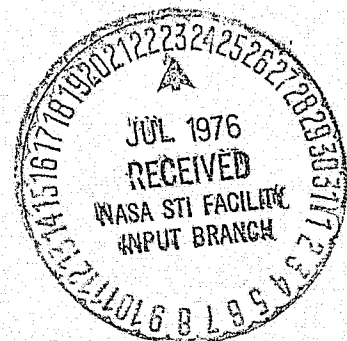
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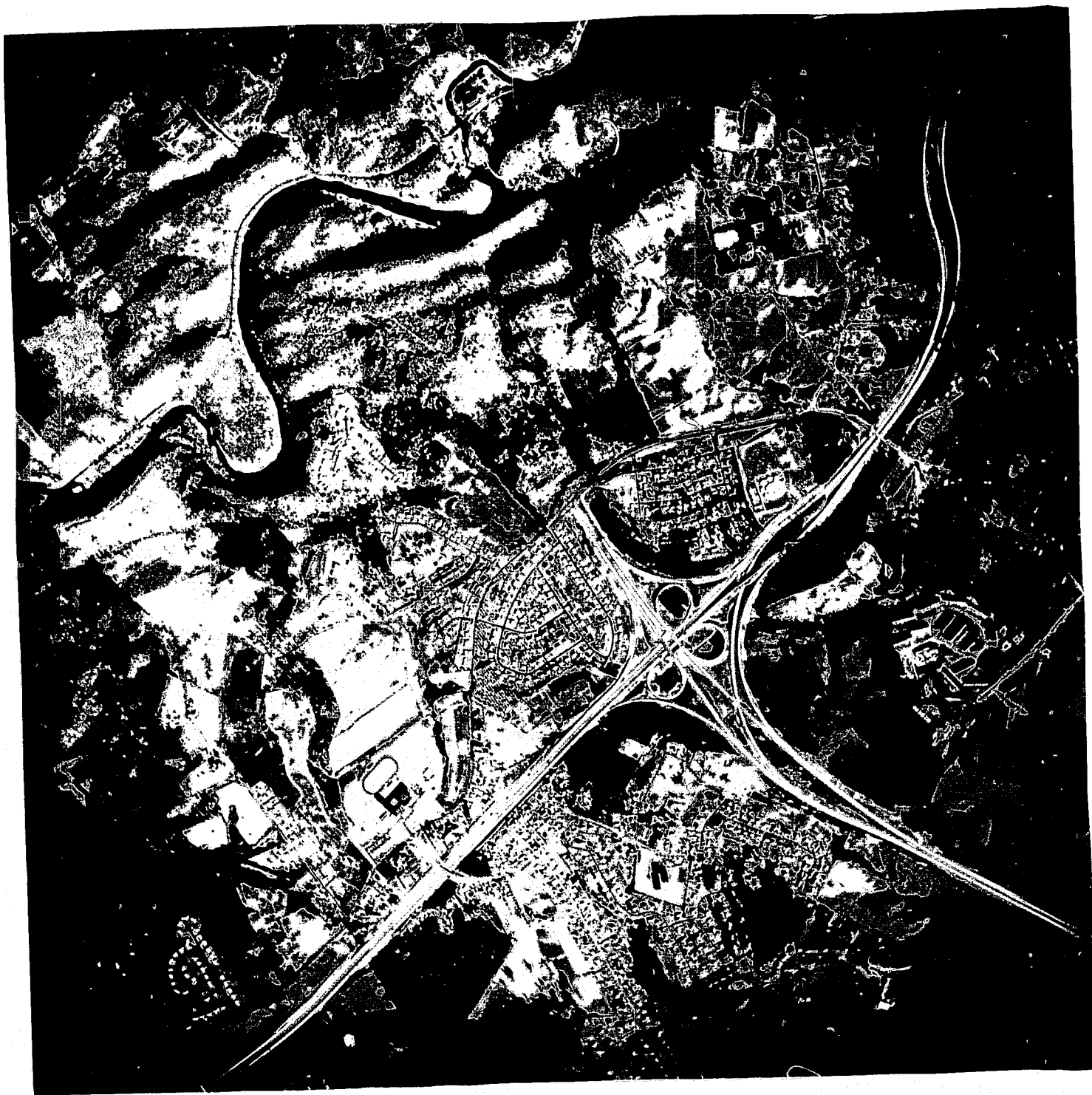
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16. Abstract A nine-month study was conducted to assess the effectiveness of the NASA Wallops Chesapeake Bay Ecological Program in remote sensing. The study consisted of a follow-up investigation and information analysis of actual cases in which remote sensing was utilized by management and research personnel in the Chesapeake Bay region. The study concludes that the NASA Wallops Chesapeake Bay Ecological Program is effective, both in terms of costs and performance.					
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Interchange on Interstate 70 in Maryland's Howard County. Patapsco River at upper left. Photograph used by the Maryland Department of State Planning for studies of the Baltimore-Washington corridor. Interchange is located near the interface of suburban and rural areas. NASA Wallops photograph by Fairchild T-11 camera from C-54 aircraft at 10,500 feet. Nov. 29, 1972.

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SUMMARY

Utilization of the remote sensing technology provided through the NASA Wallops Chesapeake Bay Ecological Program was investigated in the present study. Interviews were conducted with representatives of the 24 agencies which were "primary" users--those officially requesting cooperation. An additional 41 agencies cooperated with the primary users, bringing to 65 the number of regional managerial agencies reached by the program since its inception. The managerial agencies included federal, state, county and municipal with collateral participation by universities and private firms.

The user agencies involved the remote sensing data in 136 different managerial projects, with a wide range of implications, including environmental, socio-economic, political-managerial, monetary, legal and others. Approximately 51 percent of the projects were completed at the time of the interviews. Of those completed, approximately 89 percent were considered fully successful. Only 2.8 percent were considered unsuccessful.

In a monetary aspect of the investigation, the projects in which NASA Wallops imagery was heavily involved carried price tags totalling \$1,625,600,000. Including projects with less than heavy involvement of the NASA Wallops imagery, the dollar values involved reached \$15,319,649,500. In an analysis of cost-effectiveness, results fell heavily in favor of the use of remote sensing to accomplish the goals of the specified projects. For 30 percent of the projects, effective alternatives were unavailable at any price.

The authors strongly recommend that the NASA Wallops Chesapeake Bay Ecological Program be continued and that it receive additional emphasis and support. The authors also recommend the establishment of a better

SUMMARY cont'd.

interface for coordinating the needs of the users with the remote sensing activities of the Flight Center. They further recommend the creation of an instructional course in remote sensing for personnel of regional management agencies; the course to have the corollary objective of disseminating information about remote sensing technology to the region's institutions of higher learning. They also recommend that research and development on remote sensing technology be continued unabated. Finally, the authors recommend that all equipment and facilities of the Chesapeake Bay Ecological Program be updated to bring the program's capabilities closer to the state-of-the-art.

INTRODUCTION

This report consists of documentation, evaluation and analysis of the cases in which NASA Wallops imagery and technology were requested for use by various governmental agencies and/or academic institutions in the Chesapeake Bay region.

The investigative technique used in this study was to personally interview the primary users of the NASA Wallops imagery-technology in private session. The technique was employed in an attempt to obtain any and all information from the users which would reveal the character, extent and success of the use of NASA material. The format for the interviews was established at the study's outset, but in instances where interviews failed to follow along expected lines, the format was altered to suit the occasion.

This report is designed to allow the reader to scrutinize the analysis as we have interpreted it, and to refer to the facts in the documentation whenever necessary or desirable. Much of the material presented in the report involves evaluations and judgements which are, of necessity, subjective in nature. Wherever possible, however, we have endeavored to adhere to facts and objectivity, and we are prepared to defend our interpretations as they appear in the text.

Our purpose was to conduct the study in a forthright and unbiased manner. We trust that we have been successful and that our procedures will meet with the approval of all concerned.

ANALYSIS AND DISCUSSION

User, Project and Emphasis Analysis

Imagery from the NASA Wallops Flight Center was sent directly to governmental, academic and private organizations over the four-year period, 1971-1975. The extent of usage of the information went considerably beyond the numbers of groups which initially requested information, as shown in Table 1. Whereas interviews were conducted with 24 primary users, an additional 41 groups utilized the data in cooperation with the primary users. A total of 65 user groups was thus involved with use of the data.

Cooperative use of the imagery was common, with some of the users cooperating repeatedly with other agencies in use of NASA imagery. Each of the federal agencies which received the data was also a cooperator with other agencies on additional projects. Several of the user groups which utilized the NASA Wallops data cooperatively but not as primary users were involved in more than one cooperative effort. Of these, two were federal users, two were state, one academic, and four private. The actual number of instances of cooperation from the 41 "cooperative only" users was therefore 53. The private user category accounted for six of the 12 multiple cooperative instances of use by the "cooperative only" users.

One federal agency, the U. S. Geological Survey, as well as being a primary user, was a cooperator in several instances. In the other categories of user groups, cooperation combined with primary usage was less common. Six state agencies and three academic units were primary as well as cooperative users. None of the primary users among the county and only one among the private units functioned cooperatively. Eleven federal, eight state, eight academic, three county, and eleven private users were cooperators only.

User, Project and Emphasis Analysis cont'd.

Combining all primary users and every instance of cooperative use, the data were utilized by 111 user units. In several instances, primary users utilized data from NASA Wallops and from private concerns as well. Technology utilized by private firms to provide imagery on contract is considered to be attributable, at least in part, to research and development accomplishments of NASA. Private data firms are therefore included in the report in this context.

The character of utilization by primary users of NASA Wallops imagery is shown in Table 2. Usage was found to include a notably wide range of applications. Few of the user groups were found to be narrow in the scope of their involvement. Primary users among the federal, state and county categories were heavily involved in planning for public use of natural resources, defining environmental boundaries, and the regulation and monitoring of activities involving the environment. Management and planning activities figured strongly among the governmental users, and the management and planning activities spanned all categories of use. Other activities of the governmental units included the suppression of undesirable species and activities relating to the public health.

The NASA imagery and technology is involved in many of the most crucial and timely projects facing citizens of the region and the country at this time. The projects of academic and private users were of a somewhat different orientation although of commensurate importance and equally reliant upon NASA imagery.

Environmental and political-managerial issues figured heavily in the activities of all but two users, socio-economic issues in all but eight, monetary issues in all but 15, legal issues in all but 17, and "other"

User, Project and Emphasis cont'd.

(maps, publications, etc.) in all but 16. For the purpose of this study, the "environmental" category was intended to include primarily aspects of the physical environment. In most cases, however, the environmental considerations immediately involved human considerations and, therefore, overlapped the socio-economic category, involving public health, esthetics, recreation, and others.

The political-managerial aspects were restricted where possible to situations whereby environmental and human considerations were in the process of being managed by a governmental agency. Monetary considerations were also inseparable in most instances from the other major categories. It was obvious to the interviewers during the progress of this study that the array of projects involving NASA imagery will touch virtually every citizen in the region in one or more of the definable categories. Many of the implications will be national and international in scope. The vital nature of the environmental, socio-economic, and political-managerial categories may be readily seen in the discussion of projects which will follow. Monetary implications are far-reaching and involve every aspect of the study. Their aspects are given separate treatment in this analysis, as is personal testimony of the users as to the success and vital nature of NASA imagery and technology, or comments adverse to its use.

In the legal category, the NASA Wallops imagery was utilized directly in a number of court cases, and the imagery was seen to be a key instrument for portraying environmental phenomena. Whereas the outcome of court trials involving this imagery usually fell short of conviction, commonly concessions were won, and persons or groups engaging in activities detrimental to the environment or in non-compliance with the law were forced

User, Project and Emphasis cont'd.

to alter their methods. This was true in the nine dredging and filling cases in Delaware cited by the U. S. Fish and Wildlife Service, the Ocean City shoreline development case cited by the U. S. Geological Survey, and others. Where the users of NASA imagery suffered reverses in court, such reverses were not traced to any flaw in the presentations. The interviewers detected via the interviews a reluctance on the part of legal authorities to be overly harsh with offenders engaged in private enterprise where the violation had been of newly-established environmental regulations. The interviewers wish to emphasize that NASA imagery-technology has come to be regarded as an acceptable and cogent form of evidence in courts, despite the fact that legal cases in which it was used have been terminated short of the conviction of defendants.

The category labeled "other" may tend to be reduced in the mind of the reader below its proper level of importance. However, the far-reaching implications of maps, charts, and scientific publications should be emphasized. Maps and charts are important forms of communication whose uses and ramifications are extensive and invaluable for many specific uses. Few other methods exist for recording and systematically presenting great quantities of data regarding natural features and resources. Moreover, the utility of such information extends into the future for an indefinite period. In the category of maps and charts, the NASA imagery-technology plays one of its most valuable and vital roles. The effects upon society of publications and presentations are also extensive in their potentials, both for the present and the future. Their full impacts defy instant assessment. The present study revealed that significant contributions in the categories of maps, charts and other printed material have been produced by users

User, Project and Emphasis cont'd.

interviewed to date, with NASA imagery-technology involved and in some cases directly responsible for their existence.

A full listing of projects involving NASA imagery and technology is presented in Table 3, along with an assessment of the stage of completion of the project and the success of the user in utilizing the data for his intended purposes. In Table 3 we also attempt to reveal the various implications of each individual project according to area of emphasis. The 24 primary users interviewed in the study indicated their utilization of NASA imagery-technology in a total of 136 projects, of which 70 have been completed, 51 are presently in progress, and 13 are in the planning stage. Two were not evaluated because their status with NASA was not fully established.

Assessments of success were made only on the completed projects. Although a "success to date" was considered for projects in progress, the category was not included because the projects varied greatly in their degree of completion. Among the 70 completed projects, 62 were rated fully successful in the area of their primary emphasis, 6 moderately successful, and 2 unsuccessful. The projects which ended less than fully successful were considered to be small in number, and for reasons not attributable to any flaw in the NASA program. With a full success rate exceeding 88 percent, the program of the Chesapeake Bay Ecological Data Center appeared overwhelmingly successful.

The designation of primary emphasis for each project was done to facilitate analysis and to identify the character of each project. In Figure 1 percentages of all projects in the study are shown according to their areas of primary emphasis. The highest percentage of projects

User, Project and Emphasis cont'd.

(47%) emphasized political-managerial aspects, followed in descending order by environmental (17%), other (11.9%), socio-economic (10.4%), legal (8.4%), and monetary (4.5%).

Although each project had a primary emphasis, most had one or more additional emphases among the six descriptive categories as previously defined. Numbers of projects having emphases in several categories are shown diagrammatically in Figure 2. The "environmental" category included considerations by the largest number of projects (122), followed in descending order by "political-managerial" (114), "socio-economic" (95), "other" (71), "monetary" (54) and "legal" (37). Environmental issues, therefore, permeated a greater number of projects than any other category, even though the environmental category held second place in terms of primary emphasis. Political-managerial aspects held substantial status in both respects.

An analysis of degrees of secondary emphases corresponding to major emphases in the various categories is presented in Figure 3. Environmental emphasis corresponded with all other disciplines to a greater degree than any other category. Political-managerial considerations followed environmental considerations for every major category except "other"; in this category, monetary and socio-economic interests exceeded the political-managerial.

The process of analyzing the large amounts of information accumulated through the interviews required a grouping of projects according to managerial lines. This grouping is presented in Figure 4 with percentages of projects in each category. As the figure demonstrates, the managerial topic of "wetlands and coastal" included 42.6% of the projects in the study. Extensive attention in this direction seems appropriate, considering that NASA Wallops is located near the center of the Bay region, and that numerous

User, Project and Emphasis cont'd.

and serious wetlands and coastal problems face the various management agencies of the region. The managerial categories of land use, public health and pollution, and agriculture and forestry followed wetlands and coastal in descending order. The remaining categories contained smaller percentages of the projects.

Monetary Aspects of the Chesapeake Bay Ecological Program

Note- This report's monetary assessment was never intended to be a stringent one. The authors see the need for a rigorous, in-depth study to document properly the extensive, economic implications of the Chesapeake Bay Ecological Program.

In assaying the monetary aspects of the utilization of NASA Wallops remote sensing data by Chesapeake Bay region users, it was apparent that every Wallops cooperative project carried an intrinsic dollar cost. However, only projects demonstrating a significant dollar value which could be readily identified were selected for a monetary rating. The monetary evaluations are limited to aspects for which data were available through personal communication in interview or in existing literature.

To the investigators performing the evaluation, the most significant monetary aspect of the use of remote sensing data may well be the capability of users to identify the causative agents of environmental catastrophes. If responsibility could be assigned to an individual or corporate entity, then compensation could be sought by the injured parties through the judicial process. It is felt that this would be particularly plausible in cases where the public health has been affected or public recreational facilities have been damaged, instances with precedents for the assignment of dollar values.

The Wildlife Recreation Industry—The imagery obtained during the remote sensing flights of the Chesapeake Bay Ecological Program has been utilized directly or indirectly for the surveillance and mensuration of an appreciable percentage of the coastal and interior land and waters of the states which

Monetary Aspects of CBEP cont'd.

bound the Chesapeake Bay. The wildlife recreation industry is of considerable economic significance across this broad area and the Ecological Program has contributed importantly to the management of the industry.

The magnitude of the monetary impact of the wildlife recreation industry receives testimony through citations from a survey conducted in the southeastern states (eight) which include Maryland, Virginia and North Carolina. According to the survey, total out-of-pocket expenses for wildlife-oriented activities for the year 1971 was \$4.1 billion. The total monetary figure realized in the southeast in 1971 from the utilization of wildlife resources was \$24.2 billion. Total amount of money which would have been demanded by the participants if they had been required to give up all their participation during the year was \$31.5 billion. (The last figure was obtained by asking participants through personal interview to estimate wages and salaries they were willing to forego to engage in wildlife recreation.)

Chesapeake Bay Recreational Fisheries--The annual economic value of Maryland's part of the Bay's recreational fisheries is estimated at \$145 million (4). The value of Virginia's share was estimated to be similar (4). Thus, the total revenue from recreational fishing was about \$290 million. The same report estimates the combined revenue from the commercial and recreational fisheries of the Chesapeake Bay to amount to about \$413 million. Readers should be aware that this revenue represents not the total value of the Bay's fisheries resources, but rather the annual interest. The total value must be equated to a capital investment that would produce this annual interest at a simple interest rate of 6%--or about \$6.7 billion.

Crab, Oyster and Soft Clam Industries in Maryland and Virginia--Many of the investigators using the services of the Chesapeake Bay Ecological Program

Monetary Aspects of CBEP cont'd.

were concerned with safeguarding the health of the Bay's shellfish populations. The following data about the shellfish industry appeared in a publication of the Maryland Fish and Wildlife Administration (6). Harvest and dollar figures for Maryland and Virginia in 1971 were published:

Crabs:	Maryland	26.1 million lbs.	\$ 2.5 million
	Virginia	47.8 " "	\$ 3.7 "
Oysters:	Maryland	16.7 million lbs.	\$10.0 million
	Virginia	8.3 " "	\$ 5.3 "
Soft Clams:	Maryland	4.7 million lbs.	\$ 2.4 million

Wetlands in the Chesapeake Bay Region--Delaware, Maryland and Virginia

each used the services of the Chesapeake Bay Ecological Program in their inventories of state wetlands. The value of such lands is sometimes discounted because much of the acreage is unsuited for normal kinds of development. Nonetheless, wetlands, even the most sodden marshes, have a significant economic value which can be quantified. Roy G. Metzgar, a Natural Resources Planner for the Maryland Department of State Planning, described the worth of Maryland wetlands in a 1973 publication (9):

35,000 waterfowl hunters ply the wetlands, spending between \$367,000 and \$612,000 annually.

An additional expenditure is the \$60,000 spent on rail and snipe hunting alone.

Fur bearer pelts to the amount of \$250,000 are sold by trappers in an average year.

The major quantifiable economic benefits associated with Maryland wetlands are most conservatively estimated at approximately \$65 million annually.

According to Metzgar (9), wetlands represent 4.8% of the state's total

Monetary Aspects of CBEP cont'd.

land area, with an assessed value of about \$4,843,600. Wetlands values range widely from \$50 to \$500 per acre, mainly dependent on location. Between 1942 and 1967, Maryland lost 23,700 acres of its wetlands, mostly due to development.

In contrast to the real estate value of wetlands is the ecological value. University of Georgia ecologist, Eugene P. Odum, calculates the total life support value of tidal marsh to be in excess of \$83,000 per acre (11).

Maryland's Saltwater Fishing Industries, Commercial and Recreational--

Maryland's commercial fishing and seafood processing industry amounts to \$30.3 million annually. Furthermore, \$20 million is spent on goods and services for saltwater sports angling each year, exclusive of boats and boating equipment (9).

Real Estate Values of the Dismal Swamp--The value of the 49,097 acres of Dismal Swamp land donated by the Union Camp Corporation to The Nature Conservancy is estimated by the Conservancy at more than \$12 million. An additional 14,341 acres purchased by the Conservancy in the North Carolina section of the Swamp, if estimated at the same rate, would be worth \$3.43 million. An appreciation of the value of the entire Swamp can be gained by multiplying the per-acre value as contained in the above transaction by the Swamp's total area of 210,000 acres. This calculation yields a value of about \$50 million (1,7).

Inspections of Wetlands Permits--A considerable economic benefit accrues to the Maryland Geological Survey through its use of NASA Wallops imagery for reviewing wetlands construction permits. Kenneth Weaver, Director of the Survey, reports that monitoring of the construction occurring along the

Monetary Aspects of CBEP cont'd.

4000 miles of coastline would be time-consuming and very costly. It is reasonable to suppose that the Survey would have to hire three additional personnel, who with their pay, travel expenses and support mechanisms, would cost \$100,000 annually.

Costs of Permit-Review Personnel--Wetlands construction permits also have to be reviewed by the Maryland Water Resources Administration. Without the availability of NASA's remote sensing services, this department would also be presented with the necessity of expending \$100,000 a year for on-site reviewing.

Shoreline Property at Ocean City, Maryland--Shoreline real estate development in the coastal zone of the Chesapeake Bay region is occurring at a rapid and accelerating pace. Monitoring of the development is the responsibility of various state and federal departments and agencies. The U. S. Army Corps of Engineers, the Maryland Geological Survey and the Maryland Water Resources Administration have each used imagery from NASA Wallops in the enforcement of shoreline construction permits.

The Corps of Engineers is presently using Wallops imagery in a series of legal cases against developers who have violated construction permits at Ocean City, Md. Huge sums of money are involved in the construction projects.

Robert Lipman (14), an appraiser for a Baltimore real estate firm, is intimately familiar with real estate values at Ocean City. He says that real estate values at Ocean City are the highest of anywhere in the Chesapeake Bay region. Oceanfront properties, unimproved, with 300-foot front footage and 500 feet deep along the "golden mile" sell for as much as \$7000 a front foot. From 80th Street to 135th Street, the average value of

Monetary Aspects of CBEP cont'd.

unimproved property is \$3000-\$3500 a front foot. From 1st Street to 80th Street, unimproved properties sell for somewhat less, about \$2000 a front foot.

An average price for front footage along the five miles of the Ocean City oceanfront where the greatest development occurs would be \$2625, yielding a total value of \$69,300,000.

Protection of Shorelines--The economics of protecting America's shorelines is contained in a report by the National Park Service (5). The report states that tens of millions of dollars in public and private funds have been spent over several decades to stabilize and protect beachfront property, yet the work has not been very effective along high energy coasts.

The National Park Service has sponsored a number of studies of Park shorelines resulting in the conclusion that beach protection is prohibitively expensive and probably destined to failure in the long run anyway. In view of the findings of the studies, the Park Service has adopted a policy of gradually abandoning all beach protection projects. The remote sensing operations of the Chesapeake Bay Ecological Program acquired imagery which was of fundamental importance in documenting the case for the change in Park Service philosophy.

The vast savings which will be generated is evident from the statistics published by the National Park Service (5):

The first barrier dunes at Cape Hatteras National Seashore were built for about \$3 million, but required \$18.3 million for maintenance between 1957 and 1972.

To stabilize the 75 miles of North Carolina Outer Banks shoreline would require an initial investment of more than \$50 million and an annual

Monetary Aspects of CBEP cont'd.

stabilization budget of \$2.5 million. These figures are conservative, since the Wilmington, N. C., District Office of the U. S. Army Corps of Engineers has estimated that the initial cost of stabilizing the Outer Banks might run as high as \$20,000 per fifty foot beach front lot, or more than \$2 million per mile.

The Corps of Engineers recently completed the "National Shoreline Study" which concluded that approximately 2700 miles of shoreline in the United States were undergoing "critical erosion." It was also estimated that remedial measures to halt erosion for these 2700 miles would cost \$1.8 billion, plus an annual maintenance cost of \$73 million. This is an average investment of \$700,000 per mile, with an annual maintenance of \$30,000 per mile.

Monetary Impact of Major Storms--The monetary impact to the Chesapeake Bay region of a major storm is sometimes almost catastrophic. This accounts for the fact that many of the users of the Chesapeake Bay Ecological Program's remote sensing activities are keenly interested in obtaining imagery of the effects of every large storm after, even during, the event.

Losses sustained by the shellfish population can be of serious proportions. Several aspects of the storm militate against the health of the population. The copious rainfall accompanying the storm can dilute the Bay's salinity to the degree that oyster mortality is high. Furthermore, conditions of low dissolved oxygen percentage and high sedimentation adversely affect the oysters. Clams, too, are adversely affected by large amounts of sedimentation.

In assessing the effects of Hurricane Agnes on the environment and organisms of the Chesapeake Bay, the Chesapeake Bay Research Council (4)

Monetary Aspects of CBEP cont'd.

reported that the storm inundated sewage treatment plants, raising the Bay's bacteria level to the point that state health departments in Maryland and Virginia closed all shellfish growing areas to harvesting.

The Maryland Department of Natural Resources (4) estimated that the effects of Hurricane Agnes were responsible for the loss of 824,000 bushels of oysters. At a dockside value of \$4.50 per bushel, this loss amounts to \$3,708,000. Seiling (4) estimated that the total loss to processors, packers and retailers, might amount to \$14,835,500.

The oyster loss in Virginia was estimated at \$7.9 million at a value of \$5.10 per bushel. After processing, the Virginia oysters would have been worth double, perhaps three to five times, the primary market value.

Otto (12) says that some of the effects of Hurricane Agnes are still being felt today. Large numbers of adult oysters were lost and food chains were disturbed to such an extent that they have not yet returned to the pre-Agnes status.

Oil Spills--Accidental oil spills are a matter of great concern to authorities and citizens of the Chesapeake Bay region. The quantity of oil spilled is rising annually around the world, and increasing fears are generated over the prospects of offshore ocean drilling and the erection of transferral installations along coastal waters and near the major estuaries.

Noel Mostert (10), author of the bestseller, Supership, writing in the Audubon magazine, describes the perils of oil spills: "The danger of oil pollution is that it strikes most constantly and destructively at the points where life in the sea exists in its most concentrated and productive form-- in the estuaries and salt marshes, the offshore shallows and the deep-welling

Monetary Aspects of CBEP cont'd.

areas."

Mostert's article reports that the Torrey Canyon spill off the Brittany coast killed 80% to 88% of the guillemots, razorbills and puffins on the island of Rouzic, an estimated toll of 10,000 birds.

On August 9, 1974, history's greatest oil spill occurred when the supertanker Metula ran aground and disgorged 16,800,000 gallons. Fortunately, the accident happened in the Strait of Magellan, one of the most remote corners of the earth. It seems almost inevitable that such a disaster will one day strike the coastline of one of the world's population centers. Should a similar spill occur in the Chesapeake Bay region, the economic consequences would be on an unprecedented scale.

Among the primary users of the Chesapeake Bay Ecological Program, the U. S. Fish and Wildlife Service and the Maryland Water Resources Administration expressed deep concern over the possibility of oil spills. Two primary users, the University of Delaware and the Virginia Institute of Marine Science, have used the remote sensing program of NASA Wallops to study the behavior of oil slicks to devise methods for cleaning up oil spills.

The cost of cleanup operations could be tremendous. Mostert says that the International TOVALOP Insurance Fund (financed by tanker owners to help pay for pollution damages) has a base fund of \$30 million.

In August 1975, the first oil spill of significant proportions struck the Chesapeake Bay region when a 200,000-gallon spill occurred in Baltimore harbor. The Environmental Protection Agency called it "a major spill."

Dutch Elm Disease--Dutch Elm Disease, known best for its blighting of the appearance of the American landscape, inflicts annual economic losses on the nation's elm tree owners which are as extensive as they are real. The

Monetary Aspects of CBEP cont'd.

importance of campaigns to combat the disease becomes evident from the National Park Service's readiness to spend \$200,000 to treat and replace the sick and dying elm trees on Park Service property in the District of Columbia in preparation for the celebration of the country's bicentennial (Hammerschlag interview). Park authorities estimate that to replace the 3000 elms they manage in the Federal District would require expenditures mounting to the millions of dollars.

Elsewhere in the land, other cities are suffering similarly from Dutch Elm Disease. The city of Buffalo lost 60,000 of its 120,000 elms between 1951 and 1971, and spent \$606,000 on its elm tree sanitation program in 1970 alone (2).

The Elm Research Institute, a private foundation dedicated to the preservation of the American elm, awarded a \$30,000 grant to the University of Wisconsin in 1969 to study the Dutch Elm Disease. Experts believe that all over the United States 1,000,000 trees are killed by the disease each year (15). Using the American Shade Tree Association's figure of \$1500 for the value of a shade tree, the value of the national loss is \$1.5 billion annually.

The Variable Oak Leaf Caterpillar Infestation on Catoctin Mountain--

Infestation by the defoliating insect, the variable oak leaf caterpillar, affected 5000-6000 acres of the Catoctin Mountain forest in Maryland's Piedmont district. Tunis Lyon, Deputy Director of the Maryland Forest Service, set the timber value of the Catoctin forest at \$300-\$400 per acre. If every tree in the infested area had been damaged beyond salvage, the loss would have amounted to between \$1.5 million and \$2.4 million.

Monetary Aspects of CBEP cont'd.

Marsh Building--Marvin Moriarty of the U. S. Fish and Wildlife Service stated that imagery would be ordered from NASA Wallops in connection with the committal of the U. S. Army Corps of Engineers to create two marshes, one in Maryland and one in Virginia. Dr. Edgar W. Garbisch (13), Director and founder of Environmental Concern, Inc., an authority on marsh creation who builds marshes by contract for the Corps, estimates that, disregarding the cost of dredging-filling operations, marshes can be vegetated for \$1000-\$2000 per acre by seeding and \$2000-\$4000 per acre by live-planting. Since marshes previously built for the Corps of Engineers have averaged 15 acres, the total cost of the two marshes mentioned by Moriarty should range between \$30,000 and \$120,000.

Maryland's Coal Industry--The remote sensing cooperation of the Chesapeake Bay Ecological Program and ERTS-1 were used for studies of the coal mining industry in western Maryland. Old sites of both surface mines and deep mines pose environmental problems which will be expensive to solve. Even mines presently operating under the relatively stringent laws of today may someday require public funds to support reclamation campaigns to meet stricter regulations of the future.

The Maryland Bureau of ~~Mines~~ has used NASA remote sensing to monitor present day strip mining operations and to estimate the scope of projected reclamation projects. Meanwhile, the excavation of coal proceeds at a quickening pace, stimulated by the nation's need for energy and by the higher market prices.

The Maryland Bureau of Mine's Fifty-Second Annual Report (3) states that 2,221,413 tons of coal were excavated in 1974 and sold for prices which fluctuated between \$30-\$40 for much of the year, averaging about \$25 a ton

Monetary Aspects of CBEP cont'd.

for the entire year. Thus, the market value of the coal mined in 1974 exceeded \$55.5 million.

In each of the instances discussed above, the remote sensing technology of NASA Wallops has played a solid role, and potentials for participation in similar work appear unlimited at present. In Table 4, dollar figures are presented with an assessment of NASA's involvement in the various projects. Through use of actual citations from the literature or from persons interviewed in the study, therefore, it may be established that the NASA Wallops program influenced a monetary package of at least \$15,319,649,500.

This figure is modest, because it reflects only a small portion of the NASA Wallops program. Extensive implications exist for which solid, quotable figures are not available. As shown in Table 4, NASA Wallops remote sensing technology was considered heavy in six of the projects, with a monetary total of \$1,625,600,000. It was involved to an intermediate degree in seven of the projects, with a total of \$170,149,500, and to a slight degree in three of the projects, with a total of \$6,773,900,000.

The information above is useful as an indicator only, and is complete in only a few aspects. Any more extensive inquiry into the monetary implications of the NASA Wallops program was beyond the scope of this investigation, and would require further studies.

The aspect of cost-effectiveness of remote sensing technology is treated in Figure 5. It was deemed necessary to limit this analysis to completed projects utilizing NASA Wallops imagery in which a clear monetary implication was present. Twenty such projects were available for inclusion, and are presented in the figure. In evaluating cost-effectiveness, our best option

Monetary Aspects of CBEP cont'd.

was to consider costs and effectiveness of the use of alternate methods to remote sensing in each of the projects listed. The questions asked were, if the project were attempted by a means other than remote sensing, (1) what would be the comparative costs (compared to the use of remote sensing), and (2) what would be the comparative effectiveness?

The results of this leaned heavily in favor of the use of remote sensing, both in costs and in effectiveness. In more than 50% of the projects, alternate methods were rated less than equally effective, disregarding costs, and in 30% of the projects, alternate methods would be considered ineffective (compared to doing the same job utilizing remote sensing), regardless of costs. In 20% of the projects, the alternate methods were assessed as prohibitive cost-wise as well as ineffective in their results. In none of the projects was the alternate method assessed as less costly, and in only one was it listed as more effective. In 20% of the projects, the alternate method was assessed as "equal in effectiveness" but at a "much greater" cost. In an additional 20%, the alternate method was assessed "equal in effectiveness" at "greater" cost, and in one project the assessment of the alternate method was equal in cost and equal in effectiveness.

The essence of this treatment, in the opinion of the authors, indicated that the alternate methods are less effective and more costly than use of remote sensing in the projects examined. Certain working assumptions were utilized in this treatment, however. First was the disregarding of the research and development expenses of remote sensing technology at its present state--the premise being that remote sensing technology was an offshoot of a major governmental program which had its own separate objectives and which would have been conducted regardless of the remote

Monetary Aspects of CBEP cont'd.

sensing aspect. Second was the recognition of the advanced capabilities of remote sensing techniques, and the possibilities for such features as an instant record of a large region, which are vital to certain projects, and virtually impossible to achieve through conventional methods. Third was the working policy of considering remote sensing costs as though they were contracted through a private data firm, and not as though the service was granted virtually free through NASA.

In a final treatment of monetary implications, the completed projects with monetary significance are categorized along managerial lines and accompanied by monetary figures for each category, as shown in Figure 6. The data from which Figure 6 was derived are figures cited in the first portion of the monetary section, and were quoted in existing literature and in personal communication. Recreational wildlife constituted a strikingly large portion of the monetary whole.

ANALYSIS AND DISCUSSION cont'd.

User's Testimony

We have attempted to group user's testimony into three major categories, as shown in Table 5. Included in Table 5 are comments, both solicited and unsolicited, encountered during interviews. Some users could not be prodded into any tangible commentary either pro or con concerning their opinions of the NASA program. A small number requested that remarks told us in confidence be discreetly used; for this reason we did not identify the comments by user's name and organization in Table 5.

As shown in Table 5, the preponderance of testimony was highly supportive of the NASA Wallops program. It is important to state at this time that the most significantly favorable testimony to the NASA program was offered by the most important of agencies involved in projects of highest priority in areas concerning the environment, socio-economics, and political-managerial aspects. Their testimony was essentially that without remote sensing their alternatives would be comparatively primitive in nature, and their results much less significant. The reader should keep in mind that we are speaking of projects and areas of endeavor to which remote sensing is especially applicable.

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

Findings: Remote Sensing and Regional Management

The ecology of the Chesapeake Bay region has been better managed because of the cooperative remote sensing program of NASA Wallops. The environment--terrestrial, sub-surface, aquatic, and atmospheric--is being managed more intensively and more successfully than ever before.

The official management agencies on the federal, state and county levels have participated in the remote sensing projects conducted under the NASA Wallops Chesapeake Bay Ecological Program. These managers find that they are able to monitor aspects within their purview which previously they had monitored ineffectively or not at all. The testimony of these managers in the course of interviews conducted during the preparation of this report was that remote sensing was definitely superior to old-style aerial surveillance.

The official management agencies have found that remote sensing allows their small staffs to carry out more work and in a shorter time than ever before. They find that remote sensing data are highly valuable for making rapid assessments and for obtaining quick, accurate overviews of situations. The managers have displayed an alacrity for turning to remote sensing whenever a new problem presents itself. They manifest a readiness to utilize remote sensing whenever a subject is amenable.

These management agencies are keenly aware that remote sensing means cost-benefits to many of their operations. The Maryland Department of State Planning wrote in the publication, "Investigation of Application of ERTS-1 Data to Integrated State Planning in Maryland," Jan. 1975, that the Department had made careful cost comparisons of planning data and proved

Findings: Remote Sensing and Regional Management cont'd.

to themselves that remote sensing was cost-effective in terms of man-hours spent and cost-per-square-mile.

The management talents of remote sensing are manifold. In its short history, it has proved to be such an outstanding detector of pollution that management is coming to rely on it to identify and appraise sources of environmental contamination. In addition, management is coming to realize remote sensing's powerful potential for enforcement purposes.

Remote sensing has assumed an important role in the aftermath of natural disasters. When hurricanes and large storms strike the Atlantic seaboard, the managers wait anxiously to learn what the effects have been. In the past, the results have been slow in coming in. The extent of the destruction and alteration often was not apparent until long after the event. Remedial action could not be initiated until a protracted period of time had elapsed. The advent of remote sensing has shortened the waiting period. Satellites and high-flying aircraft can furnish synoptic views of the affected area immediately after, and sometimes during, the event. Managers are thus enabled to deal quickly and advisedly with the storm's effects.

Management agencies, especially at the state and local levels, have limited financial resources. Programs are often implemented which must be curtailed or aborted when the money runs out. The cooperation of NASA often has meant that programs, which might otherwise atrophy or die, can be prosecuted to a successful conclusion.

For example, the Virginia Division of Forestry hired private airplane flights to survey the pine bark beetle outbreak in Accomack and Northampton Counties. The long series of flights necessary for identification and

Findings: Remote Sensing and Regional Management cont'd.

surveillance might have become too expensive and conceivably the campaign to combat the beetle might have been abandoned except for the support of the Chesapeake Bay Ecological Program.

The management of the resources of the Chesapeake Bay region is being carried out by remote sensing in the manner that the managers had always wanted, but had never been able to do. To ratify this statement, consider the matter of sedimentation in the Chesapeake Bay. Before remote sensing, the information available on Bay sedimentation was incomplete. The volume of sediment introduced into the Bay could be estimated by on-site measurements at various points in the Bay, but the overall load at any particular time was not known to the desirable degree of accuracy. Furthermore, the smaller sources of sedimentation were unidentified and unmeasured.

Remote sensing has not only made it possible to measure the entire contribution of sediment to the Bay but has enabled observers to study the pattern and changes in sedimentation plumes.

Remote sensing of the Bay's sedimentation is so superior to old methods that managers will never be able to do without it again.

The remote sensing cooperation of the Chesapeake Bay Ecological Program has played an unanticipated role in the management of the ecology of the region—the role of leader and unifier. This is because the participation of NASA in projects confers an aura of importance and dignity which conduces to multiple-participation by managers at various political levels and from various regimes.

It is doubtful if such diverse participation could ever be effected without the leadership of a large and respected agency as NASA.

Findings: Remote Sensing and Regional Management cont'd.

Restating this thought, the participation of NASA ensures that the objective(s) of a project will receive broad and intensive treatment. The principle of multiple-participation, although earnestly sought, is rarely achieved because of the practical difficulty of evoking the interest and enthusiasm of the potential participants.

In such large projects, NASA's role is almost the opposite of what was originally intended: NASA becomes the leader rather than the accessory. With NASA's participation in a project, ancillary research studies are likely to be undertaken. These subordinate investigations evolve with the spreading realization of the rich potential inherent in NASA's services and resources.

Remote sensing's important position in the management of the Chesapeake Bay region can be verified by the fact that so many sectors of the management spectrum are using remote sensing. When it is considered that even the largest private land managers like The Nature Conservancy are using remote sensing, there can be no disputing that remote sensing has proven itself "in the trenches."

Remote sensing's record for sampling, measuring, evaluating and monitoring in a fraction of the time and at a lower cost than alternative methods has won the allegiance of high-level administrators. The Secretary of the Maryland Department of Natural Resources has administered projects operating under the cooperation of the remote sensing program of NASA Wallops since the inception of the space agency's program when the Secretary served as a deputy in the Department and helped lay the ground work for the state's first cooperative projects with NASA.

The Governor of Massachusetts signified his confidence in the capability

Findings: Remote Sensing and Regional Management cont'd.

of NASA's remote sensing program to assist in the amelioration of serious ecological problems when he addressed a letter directly to James C. Fletcher, NASA Administrator, to enlist the remote sensing cooperation of the space agency in a major study of coastal and estuarine zones to stem the decline of the state's commercial fisheries industry.

As a final testimony to the general recognition of the ability of NASA remote sensing to make significant contributions to the needs of management, the following quotation is presented from the "Investigation of Application of ERTS-1 Data to Integrated State Planning in Maryland" (January 1975), a report to NASA from the Maryland Department of State Planning:

"The interest and support of this (remote sensing) investigation by the Governor of Maryland has been demonstrated both in words and actions. After reviewing ERTS-1 and aircraft imagery, Governor (Marvin) Mandel initiated efforts to disseminate data and results of the investigation to additional user groups in Maryland. At the Southern Governors Conference, the Governor strongly encouraged his colleagues...to manage their own state's resources with these data."

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS cont'd.

Conclusions and Recommendations

The present study has spanned most of the utilization of NASA Wallops imagery which has comprised the NASA Wallops Chesapeake Bay Ecological Program, and the results have been analyzed and evaluated in various directions. The authors offer, as an outgrowth of user interviews, the following conclusions and recommendations.

CONCLUSIONS:

A- The authors conclude that the NASA Wallops remote sensing program has reached a substantial proportion of the management agencies in the Chesapeake Bay region, and that the program is involved in the region's most important ecological management projects.

B- The authors conclude that the management of the Chesapeake Bay region has been notably enhanced by the NASA Wallops remote sensing program.

C- The authors conclude that remote sensing is cost-effective, and that the use of alternative methods is unacceptable and regressive at man's present stage of technological development.

D- The authors conclude that NASA Wallops has made wise and effective use of the remote sensing resource in its charge in the selection of primary cooperators. This conclusion is derived from the impressiveness of the personnel and projects among the primary cooperators. Project leaders are preeminent in the fields of administration, management and science, and their accomplishments with remote sensing have been extensive.

E- The authors conclude that, despite the easily recognizable effectiveness of remote sensing as a management tool, responsibility for the

Conclusions and Recommendations cont'd.

continued development and support of remote sensing will not be assumed by other agencies or private companies at this time. It is the authors' conviction that this new and developing technology needs the sponsorship and guidance of the NASA Wallops Flight Center for at least another decade before it can be expected to proceed viably on its own.

In light of the results of their study as documented in this report, the authors make the following recommendations.

RECOMMENDATIONS:

A- The authors vigorously recommend that the NASA Wallops Chesapeake Bay Ecological Program not be terminated or curtailed, rather that it receive additional support and emphasis.

B- The authors recommend that a better interface be established to coordinate user needs with the NASA Wallops remote sensing activities.

C- The authors recommend that an instructional program in remote sensing for regional management users be created as part of the Chesapeake Bay Ecological Program. An additional goal of the instructional program should be to dispense knowledge in remote sensing technology to appropriate departments in schools, colleges, universities and other applicable places of instruction.

D- The authors recommend that the use of present remote sensing knowledge be increased, and that research and development of new technology should proceed vigorously.

E- The authors recommend strongly that all equipment and facilities of the Chesapeake Bay Ecological Program be updated to bring the program's capabilities closer to the state-of-the-art.

TABLE 1. USER'S LISTING AND COOPERATION MATRIX

PRIMARY USER OF NASA WALLOPS IMAGERY	COOPERATING AGENCY				
	FEDERAL	STATE	UNIVERSITY & COLLEGE	COUNTY	PRIVATE
<u>FEDERAL</u>					
U.S. Geol. Survey	Tree Ring Aging Lab. (USGS) Eight separate federal agencies (Dismal Swamp); esp. U.S. Forest Service	Md. Dept. of Ches. Bay Affairs Va. Dept. of Water Resources			
Nat. Park Service	U.S. Dept. of Agr. Shade Tree Group Research Station (U.S. For. Serv.) National Space Tech- nology Laboratory U.S. Geol. Survey		Univ. of Mass. VPI & SU Penn. St. Univ. Univ. of Maine Univ. of Md. Univ. of Ga. The American Univ.		Spectral Data Company
U.S. Fish and Wild- life Service	U.S. Army Corps of Engineers Patuxent Migratory Waterfowl Lab. U.S. Geol. Survey U.S. Dept. of Int.				Environmental Concern, Inc.
U.S. Army Corps of Engineers	U.S. Fish and Wildlife Service U.S. Geol. Survey	Md. Water Resources Administration Virginia Institute of Marine Science	The American Univ.		

TABLE 1. USER'S LISTING AND COOPERATION MATRIX

PRIMARY USER OF NASA WALLOPS IMAGERY	COOPERATING AGENCY				
	FEDERAL	STATE	UNIVERSITY & COLLEGE	COUNTY	PRIVATE
<u>STATE</u>					
Md. Dept. of State Planning	U.S. Geol. Survey U.S. Dept. of Hous- ing and Urban Development			Tri-County Council of South- ern Maryland	Earth Satellite Corporation
Md. Water Resources Administration			Center for Environmental and Estuarine Studies (Univ. of Md.)		Smithsonian Institute Photoscience, Inc. Raytheon, Inc.
Md. Geol. Survey		Md. Dept. of Nat. Resources			Greene Associates
Md. Forest Service					Delmarva Pine Bark Beetle Council
Md. Bureau of Mines- Md. Geol. Survey					
Md. Dept. of Chesa- peake Affairs	U.S. Geol. Survey				Photoscience, Inc. Raytheon, Inc.
Va. Division of Forestry-Insect & Disease Invest- igations	U.S. For. Service	Md. For. Service Del. For. Service Va. Inst. of Marine Science	Univ. of Michigan		Smithsonian Inst. Delmarva Pine Bark Beetle Council

TABLE 1. USER'S LISTING AND COOPERATION MATRIX

PRIMARY USER OF NASA WALLOPS IMAGERY	COOPERATING AGENCY				
	FEDERAL	STATE	UNIVERSITY & COLLEGE	COUNTY	PRIVATE
<u>STATE</u> (cont'd)					
Va. Insitute of Marine Science	U.S. Nav. Research Lab. U.S. Coast Guard Atomic Energy Comm. Environmental Pro- tection Agency				
<u>UNIVERSITY & COLLEGE</u>					
Penn. State University			Penn. State Univ.-- Depts of Agr., Arch. & Engin. Marine Science Con- sortium--two univ- ersities & colleges		Clinton Co. (Pa.) Land Use Planners
Univ. of Delaware-- College of Marine Studies	U.S. Bureau of Land Management Office of Naval Research				
Univ. of Washington-- Dept. of Anthro- pology		Md. Water Resources Administration Md. Dept. of Natural Resources			Smithsonian Inst.
Va. Polytechnic Inst. & State Univ.		Va. Truck & Ornamentals Research Station			

TABLE 1. USER'S LISTING AND COOPERATION MATRIX

PRIMARY USER OF NASA WALLOPS IMAGERY	COOPERATING AGENCY				
	FEDERAL	STATE	UNIVERSITY & COLLEGE	COUNTY	PRIVATE

<u>UNIVERSITY & COLLEGE</u> (cont'd)					
Univ. of Massachu- setts--Cooperative Park Studies Unit & Coastal Research	National Park Service	Massachusetts Office of Environmental Affairs	Univ. of Mass.-- Dept. of Geology		The Nature Conser- vancy
Univ. of Virginia-- Dept. of Environ- mental Sciences	National Park Service U.S. Army Corps of Engineers	Md. Geol. Survey	Va. Inst. of Marine Science Univ. of Mass.		Westinghouse Corp.
Center for Environ- mental & Estuarine Studies--Univ. of Md.	U.S. Fish & Wildlife Service	Md. Dept. of Nat- ural Resources			
<u>COUNTY</u>					
Chester County (Pa.) Board of Health	U.S. Geol. Survey	Pa. State Police Wilmington (Del.) Water Dept.		Chester Co. Bd. of Realty Chester Co. Water Resources Auth- ority	
Accomack-Northampton (Va.) Planning District Commission		Va. Bureau of Shellfish Sanitation Va. Forest Service			

TABLE 1. USER'S LISTING AND COOPERATION MATRIX

PRIMARY USER OF NASA WALLOPS IMAGERY	COOPERATING AGENCY				
	FEDERAL	STATE	UNIVERSITY & COLLEGE	COUNTY	PRIVATE
<u>PRIVATE</u>					
Rudolph Baliko-- Forestry Consultant	U.S. Forest Ser. NASA	Va. Forest Service Md. Forest Service Del. Forest Service			Delmarva Pine Bark Beetle Council Bendix Aerospace Systems Division
The Nature Conser- vancy	U.S. Geol. Survey		Univ. of Mass.-- Dept. of Botany		
Ecology & Environ- ment, Inc.	National Park Service				

TABLE 2. RATING INDICES OF NASA WALLOPS IMAGERY USES ^{1/}

	Environ- mental	*Socio- economic	Political- Managerial	*Monetary	Legal	Other ^{2/}
<u>FEDERAL</u>						
U.S. Geol. Survey (USGS)	X	X	X	L	O	X
National Park Service (NPS)	X	X	X	X	O	L
U.S. Fish & Wildlife Service	X	X	X	X	X	L
U.S. Army Corps of Engineers	X	X	X	M	X	O
<u>STATE</u>						
Md. Dept. State Planning	X	X	X	X	X	X
Md. Water Resources Administration (General Permits Section)	X	M	X	L	X	O
Md. Geol. Survey	X	X	X	X	X	X
Md. Forest Service	L	O	M	O	O	O
Bureau of Mines (Md. Geol. Survey)	X	X	X	M	L	M
Md. Dept. of Chesapeake Bay Affairs	X	L	X	M	X	M

^{1/} Rating Index, see page 40

^{2/} Academic, maps, publications, graphics, etc.

* Definition of this term on page 40

TABLE 2. RATING INDICES OF NASA WALLOPS IMAGERY USES ^{1/}

	Environ- mental	Socio- economic	Political- Managerial	Monetary	Legal	Other ^{2/}
<u>STATE (cont'd)</u>						
Va. Division of Forestry	X	X	X	X	O	L
Va. Institute of Marine Science	X	X	X	O	L	M
<u>UNIVERSITY AND COLLEGE</u>						
Penn. State University	X	X	X	L	O	L
Univ. of Delaware - College of Marine Studies	X	M	X	M	M	X
Univ. of Washington - Dept. of Anthropology	X	M	X	L	L	X
Va. Polytechnic Institute & SU	X	X	X	X	M	X
Univ. of Maryland - Dept of Agronomy	M	O	M	O	O	X
Univ. of Massachusetts - Cooperative Park Studies Unit	X	X	X	X	L	X
Univ. of Va. - Dept. of Environmental Sciences	X	X	X	X	O	L
Center for Environmental & Estuarine Studies - Univ. of Md.	X	L	X	L	O	M

TABLE 2. RATING INDICES OF NASA Wallops Imagery Uses ^{1/}

	Environ- mental	Socio- economic	Political- Managerial	Monetary	Legal	Other ^{2/}
<u>COUNTY</u>						
Chester Co. (Pa.) Bd. of Health	X	X	X	O	X	O
Accomack-Northampton (Va.) Planning District	X	X	X	M	X	X
<u>PRIVATE</u>						
Rudolph Baliko, Forestry Consultant	X	X	X	X	O	M
The Nature Conservancy	X	M	X	L	L	M
Ecology & Environment, Inc.	X	X	X	X	O	L

Rating Index: X - intensive use
M - moderate use
L - light use
O - no use

- * Socio-economic: affecting the cultural activities, health and general welfare of the citizenry.
- * Monetary: pertaining to the financial effects on government, private enterprise and individual citizens.

TABLE 3. PROJECT RATING INDEX ^{1/}

("Socio-economic" and "monetary" defined on page 40.)

PROJECT	Environ- mental	Socio- economic	Political- Managerial	Monetary	Legal	Other
<u>FEDERAL</u>						
<u>U.S. Geol. Survey; Cooperative with Federal and State</u>						
Freshwater Wetlands on Patuxent & Elk Rivers (Md.)	*C-1					
Effects of Hurricane Agnes on Small Marsh	*P					
Study of Coastal Salt Marshes on Chincoteague Bay	*C-1		C-1			
Wooded Swamps Along Pocomoke River (Md.)	I		*I			
Multi-faceted Study of Dismal Swamp	*I	I	I	I	I	I
<u>National Park Service; Cooperative with Federal, University & College and Private</u>						
Dutch Elm Disease Projects	I	*I	I	I		I

^{1/} Rating LegendPresent stage of completion

C = Completed
I = On-going
P = Planned

Success of Use of NASA Imagery According to User's Assessment

1 = Fully Successful
2 = Moderately Successful
3 = Unsuccessful

* Asterisk denotes primary emphasis

TABLE 3. PROJECT RATING INDEX ^{1/}

PROJECT	Environ- mental	Socio- economic	Political- Managerial	Monetary	Legal	Other
<u>U.S. Fish and Wildlife Service; Cooperative with Federal and Private</u>						
Flood Protection Projects at Virginia Beach	I	I	*I	I		
Dredging and Filling Cases in Delaware					*C-2	
Private Developer Dredging and Filling Case					*C-2	
Chincoteague Island Dredging and Filling Case					*C-3	
Hampton Roads, Virginia, Application for Fill Permit	C-1	C-1	*C-1	C-1	C-1	
Malaise in Wild Waterfowl Due to Water Pollution	I	*I	I	I	I	
Pesticides in Chesapeake Bay - Chester River	P	*P	P		P	
Mosquito Ditching Projects	P	P	*P			
Migration of Tangier Island	I	I	I	*I	I	
Sussex Co., Del., Illegal Filling Case					C-1	
Marsh Creation Projects	*P	P	P	P		
Fish Habitat in Rivers	*P	P	P	P		
<u>U.S. Army Corps of Engineers</u>						
Court Prosecution of Permit Violations	C-1	C-1	C-1	C-1	*C-1	

TABLE 3. PROJECT RATING INDEX ^{1/}

PROJECT	Environ- mental	Socio- economic	Political- Managerial	Monetary	Legal	Other
<u>STATE</u>						
<u>Maryland Department of State Planning; Cooperative with State and Private</u>						
Land Use Inventory of Maryland, 1970	C-1	C-1	*C-1			C-1
Route for Baltimore - Washington Corridor	I	I	*I	I	I	
Land Use Map of Harford County, 1973	C-1	C-1	*C-1			C-1
Verification of Planning Data (Periodic)	I	I	*I			I
Location of Marriott Amusement Park	C-1	C-1	C-1	C-1	*C-1	C-1
Comprehensive Land Use Plan for Maryland	I	*I	I	I	I	I
Agricultural Land Inventory	*I	I	I			
Septic Tank Failure in Kent County	C-3	*C-3	C-3			
Inventory and Review of Maryland Surplus Land	I	I	*I	I	I	I
General Information - (Historical Sites, Location of Structures, etc.)	I	*I	I	I	I	
Up-dating Land Use Inventory	I	I	*I	I	I	I
Oil Spill Cases - Leonardtown, Maryland	C-2	C-2	C-2	C-2	*C-2	
Request for Permits for Oil Refinery	C-1	C-1	C-1	C-1	*C-1	

TABLE 3. PROJECT RATING INDEX 1/

PROJECT	Environ- mental	Socio- economic	Political- Managerial	Monetary	Legal	Other
<u>Maryland Department of State Planning; Cooperative with State and Private (cont'd)</u>						
Mapping Flood Plains in Flood-Prone Areas	*P	P	P			
Maryland Automated Geographic Info System	I	I	*I	I	I	I
<u>Maryland Water Resources Administration; Cooperative with University and College, Private</u>						
Preparation of Maryland Water Resources -44- Wetlands Map	*C-1		C-1			
Wetlands Verification Case-Value Assessment					C-1	
Rhode River Estuary Study	*C-1		C-1			
Monthly Processing of Wetland Permit Applications	I	I	*I	I	I	
Determination of Mean High Water Lines	*C-1		C-1			
Management Decisions Concerning Shoreline Studies	I	I	*I	I	I	
Enforcement of Water Resources Permit Situations	I	I	I	I	*I	
<u>Maryland Geol. Survey; Cooperative with State and Private</u>						
Evaluation and Inventory of Maryland Mineral, Soil and Water Resources	I		*I			

TABLE 3. PROJECT RATING INDEX ^{1/}

PROJECT	Environ- mental	Socio- economic	Political- Managerial	Monetary	Legal	Other
<u>Maryland Geol. Survey; Cooperative with State and Private (cont'd)</u>						
Ocean City, Maryland, Shoreline Development	C-1	C-1	C-1	C-1	*C-1	
Monitoring of Atlantic Coast Line	I		*I			
Preparation of Environmental Atlas of Maryland	I	I	*I	I		I
Inventory of Sand and Gravel Pits Along Baltimore - Washington Corridor	C-1		*C-1			
Selection of Chesapeake Bay Spoilage Sites	I	I	*I	I		
Hart and Miller Islands, Baltimore Harbor, as Long-Term Spoilage Site	I	I	*I	I	I	
Effects of December, 1974, Storm on Hart and Miller Islands in Baltimore Harbor	C-1		C-1	*C-1		
Study of Erosion along Potomac River Banks	*I		I			
New Knowledge about Coastal Morphology	I					*I
Plant Signature as Index to Geological Formation	I					*I
Parkville, Maryland, Ground Water Survey	C-1	*C-1	C-1			
Monitoring of Offshore Oil Drilling	P	P	*P	P		

TABLE 3. PROJECT RATING INDEX^{1/}

PROJECT	Environ- mental	Socio- economic	Political- Managerial	Monetary	Legal	Other
<u>Maryland Geol. Survey; Cooperative with State and Private (cont'd)</u>						
Enforcement of Laws Pertaining to Illegal Dredging					*C-1	
Delineating Maryland Wilderness Areas	*I	I	I			
<u>Maryland Forest Service; Cooperative with Private</u>						
Survey of Variable Oak Leaf Caterpillar	C-2		*C-2			
<u>Md. Bureau of Mines, Md. Geol. Survey</u>						
Inventory and Delineate Boundaries of Coal Strip Mines, Past and Present	C-1	C-1	*C-1	C-1		C-1
Determination of Old Deep Mine Sites	P	P	*P			
Monitor Compliance with Mining Permits	P	P	P	P	*P	
Geological Mapping of Western Maryland	I	I	*I			I
<u>Md. Department of Chesapeake Bay Affairs</u>						
Mapping Maryland Wetlands						
Basic Data for Planning Decisions in Tidewater Maryland						

(projects difficult to evaluate since no firm relationship between user and NASA Wallops was ever established.)

TABLE 3. PROJECT RATING INDEX^{1/}

PROJECT	Environ- mental	Socio- economic	Political- Managerial	Monetary	Legal	Other
<u>Virginia Division of Forestry</u>						
Delmarva Pine Bark Beetle Campaign	C-1	C-1	*C-1	C-1		C-1
Frontalure-Cacodylic Acid Experiments in Prince Edward State Forest	C-2	C-2	*C-2	C-2		C-2
Pine Bark Beetle Control Program in Cumberland State Forest	C-1	C-1	*C-1	C-1		C-1
<u>Virginia Institute of Marine Science</u>						
Study of Experimental Oil Slicks in Chesapeake Bay	C-1	C-1	*C-1		C-1	
Study of Aquatic Environment of James River Nuclear Plant	C-1	C-1	*C-1		C-1	
Study of Virginia Barrier Islands	*C-1	C-1	C-1			C-1
Assessing the Applicability of Remote Sensing to Marsh Studies	*C-1		C-1			C-1

TABLE 3. PROJECT RATING INDEX^{1/}

PROJECT	Environ- mental	Socio- economic	Political- Managerial	Monetary	Legal	Other
<u>UNIVERSITY AND COLLEGE</u>						
<u>Penn. State University; Cooperative with other Universities and Colleges</u>						
Susquehanna River Basin Studies						
Inventory and Mapping of Coal Strip Mines	C-1	C-1	*C-1			
Mapping of Land Use	C-1	C-1	*C-1			C-1
Inventory and Mapping of Coal Deep Mine Spoil Sites	C-1	C-1	*C-1			C-1
Monitoring of Gypsy Moth Infestation	C-1	C-1	*C-1			
Survey of Air Pollution Effects on Vegetation	C-1	C-1	*C-1			
Mapping of Forest Types and Vegetation Cover	C-1	C-1	*C-1			C-1
Survey of Effects of Industrial Smoke on Nearby Vegetation	C-1	C-1	*C-1			C-1
Observations of Effects of Industrial Thermal Discharge on the Susquehanna River Basin Plant Life	C-1	C-1	*C-1			
Inventory of Sinkholes in Karst Regions	*C-1					

TABLE 3. PROJECT RATING INDEX^{1/}

PROJECT	Environ- mental	Socio- economic	Political- Managerial	Monetary	Legal	Other
<u>Penn. State University; Cooperative with other Universities and Colleges</u> (cont'd)						
Location of the Overgrown Route of an Historic Canal	*C-1					C-1
Mapping Geological Lineaments				C-1		*C-1
Clinton County, Pennsylvania, Land Use Plan		I	*I			
Landscape Architecture, Professional and Student Use	I	*I				I
Educational Activities of Marine Science Consortium						*I
Penn. State University Marine Science Course						*I
<u>University of Delaware, College of Marine Studies; Cooperative with Federal</u>						
Study of Circulation Patterns of Delaware Bay	I	I	I	I		*I
Mapping of Suspended Sediments	I	I				*I
Spectral Signatures of Coastal and Estuarine Pollutants	I	I	I	I	I	*I
Photo-Optical Determination of Wave Spectra	P	P	P	P		*P

TABLE 3. PROJECT RATING INDEX^{1/}

PROJECT	Environ- mental	Socio- economic	Political- Managerial	Monetary	Legal	Other
<u>University of Delaware, College of Marine Studies; Cooperative with Federal (cont'd)</u>						
Inventory and Mapping of Delaware Marsh Vegetation	C-1	C-1	C-1	C-1	C-1	*C-1
Land Use Impact on Delaware Coastal Environment		I	*I			I
Survey of Land Use Change Along East Coast of Delaware	I	I	*I			I
Locating Chlorophyll in Oceans	P			P		*P
<u>University of Washington, Department of Anthropology; Cooperative with Federal and State</u>						
Location and Evaluation of Archeological Sites in Maryland Coastal Zone	I	I	*I			I
Development of Predictive Model for Location of Archaeological Sites	I	I	*I			I
<u>Virginia Polytechnic Institute & State University; Cooperative with State</u>						
Investigations of the Geomorphic Forms Known as Carolina Bays		C-1				*C-1
Spectral Signatures of Virginia Agricultural Crops	I	I	I	*I		I
Previsual Detection of Stressed Crops	I	I	I	*I		I

TABLE 3. PROJECT RATING INDEX^{1/}

PROJECT	Environ- mental	Socio- economic	Political- Managerial	Monetary	Legal	Other
<u>Virginia Polytechnic Institute & State University; Cooperative with State</u> (cont'd)						
Identification of Soil Types	I	I	*I			I
Virginia Beach Soils and Septic Tank Study	P	P	*P		P	P
Peanut Black Rot Disease Study	I		I	*I		
Identification of Forest Types	I		I			*I
Expanding Agricultural Base Data for other Chesapeake Bay Agr. Exp. Stations	C-1		C-1	C-1		*C-1
<u>University of Maryland, Department of Agronomy; Cooperative with State</u>						
Mapping Soil Types in Maryland Tidal Marsh Lands	I	I	*I			I
<u>University of Massachusetts; Cooperative with Parks Study Unit and Coastal Research Center</u>						
Study of Cape Cod National Seashore	I	I	*I			I
Study of Cape Hatteras National Seashore	C-1	C-1	*C-1			C-1
Study of Cape Lookout National Seashore	C-1	C-1	*C-1			C-1
Assateague Island National Seashore	C-1	C-1	*C-1			C-1

TABLE 3. PROJECT RATING INDEX^{1/}

PROJECT	Environ- mental	Socio- economic	Political- Managerial	Monetary	Legal	Other
<u>University of Massachusetts; Cooperative with Parks Study Unit and Coastal Research Center (cont'd)</u>						
Effects of Hurricane Ginger on North Carolina Barrier Islands	C-1		*C-1			C-1
Man's Impact on Barrier Islands of North Carolina	*C-1		C-1			C-1
Consequences of Barrier Island Stabilization	C-1	C-1	*C-1			C-1
Barrier Island - Ecology of Cape Lookout National Seashore	C-1	C-1	*C-1			C-1
Formation Dynamics of North Carolina Salt Marshes	*C-1	C-1	C-1	C-1		C-1
Mapping of Underwater Vegetation	C-1					*C-1
Salt Marsh Vegetation Mapping at Cape Hatteras	*C-1		C-1			C-1
Ecological Evaluation and Mapping of Massa- chusetts Estuaries	P	P	*P	P		P
<u>University of Virginia, Dept. of Environmental Sciences</u>						
Assessment of Cape Hatteras National Seashore	C-1	C-1	*C-1	C-1		

TABLE 3. PROJECT RATING INDEX^{1/}

PROJECT	Environ- mental	Socio- economic	Political- Managerial	Monetary	Legal	Other
<u>University of Virginia, Dept. of Environmental Sciences (cont'd)</u>						
Study of Assateague National Seashore	C-1	*C-1	C-1			C-1
Dune Stabilization & Beach Nourishment Projects	C-1	C-1	*C-1	C-1		
Study of Effects of Major Storms	*C-1	C-1	C-1	C-1		
Shoreline Morphology and Variability	*I		I			I
<u>Center for Environmental & Estuarine Studies, University of Maryland; Cooperative with Federal and State</u>						
Investigations of Borrow Pits - Atlantic Coastal Zone	C-2		*C-2			C-2
Animal Distribution Near In-shore Borrow Pits Behind Maryland Barrier Island	C-1	C-1	*C-1		C-1	C-1
<u>County</u>						
<u>Chester County (Pennsylvania) Health Department; Cooperative with Federal, State and County</u>						
Eruption of E. Coli in Brandywine River--Water Supply for Wilmington, Delaware	C-1	*C-1	C-1		C-1	

TABLE 3. PROJECT RATING INDEX^{1/}

PROJECT	Environ- mental	Socio- economic	Political- Managerial	Monetary	Legal	Other
<u>Accomack-Northampton (Virginia) Planning District Commission; Cooperative with State</u>						
Wetlands Observations	C-1	C-1	*C-1			C-1
Inventorying and Measuring the Peninsula's Ponds	C-1		*C-1			C-1
Observing Water Resources and Erosion Patterns	C-1	*C-1	C-1			C-1
Checking Pine Bark Beetle Damage	C-1	*C-1	C-1	C-1		
Assessing Storm Damage	C-1	*C-1	C-1	C-1		C-1
Sewage Drainage Patterns of Chicken and Food Industries	I	I	*I	I	I	
Comprehensive Planning	I	I	*I		I	I
<u>PRIVATE</u>						
<u>Rudolph Baliko - Forestry Consultant; Cooperative with Federal, State and Private</u>						
Delmarva Pine Bark Beetle Council	C-1	C-1	C-1	*C-1		
Developing Signatures for Pine Species and Reducing Existing Errors in Pine Acreage	I		*I	I		I

TABLE 3. PROJECT RATING INDEX^{1/}

PROJECT	Environ- mental	Socio- economic	Political- Managerial	Monetary	Legal	Other
<u>The Nature Conservancy; Cooperative with Federal and University and College</u>						
Vegetative Mapping of the Virginia Coast Reserve *I		I	I		I	I
An Ecosystem and Resource Management Study of the Entire Virginia Barrier Islands Chain	I	*I	I	I		I
<u>Ecology and Environment, Inc.</u>						
Tree Inoculation, Dutch Elm Disease and Urban Vegetation Stress Studies (Washington, D.C.)	C-1	C-1	*C-1	C-1		

TABLE 4. MONETARY SIGNIFICANCE OF SOME RESOURCE-MANAGEMENT AND RESOURCE-EXPLOITATION ACTIVITIES
INFLUENCED BY THE CHESAPEAKE BAY ECOLOGICAL PROGRAM 1/

Activity Category	Capital Value	Expenditures	Annual Product Sales	Losses Sustained	Influence of NASA Imagery <u>2/</u>	Monetary Bibliography Reference
Wildlife Recreation Management Administration		\$50 million/yr.			C	8
Chesapeake Bay Recreational and Commercial Fisheries Industries	\$6.7 billion				C	4
Md. & Va. Shellfish Industry			\$23.9 million		C	6
Md. Commercial Marine Fishing & Seafood Processing Industry			\$30.3 million		B	9
Md. Pelt and Hide Industry			\$799,500		B	9
Md. Wetlands Real Estate	\$4.8 million				B	9, 11
Dismal Swamp Real Estate	\$50 million				A	1, 7
Additional Personnel Needed for Permit Enforcement, Md. Geological Survey		\$100,000			A	estimated by authors

1/ Restricted to completed projects with documented monetary significance

2/ Rating Index

- A. Heavy
- B. Intermediate
- C. Light

TABLE 4. MONETARY SIGNIFICANCE OF SOME RESOURCE-MANAGEMENT AND RESOURCE-EXPLOITATION ACTIVITIES
INFLUENCED BY THE CHESAPEAKE BAY ECOLOGICAL PROGRAM

Activity Category	Capital Value	Expenditures	Annual Product Sales	Losses Sustained	Influence of NASA Imagery <u>2/</u>	Monetary Bibliography Reference
Additional Personnel Needed for Permit Enforcement, Md. Water Resources Administration		\$100,000/yr.			A	estimated by authors
Ocean City (Md.) Shoreline Real Estate	\$69 million				B	14
National Park Shorelines Maintenance		\$73 million/yr.			A	5
Effects of Hurricane Agnes on Chesapeake Bay Oyster Industry				\$11.6 million	B	4, 12
Effects of Dutch Elm Disease				\$1.5 billion/yr.	A	2, 15
Md. Forest Land Threatened by Oak Leaf Caterpillar	\$2.4 million				A	estimated by Md. For. Ser.
Marsh Building in Md. & Va.		\$120,000			B	13
Md. Coal Mining Industry			\$55.5 million		B	3

TABLE 5. USER TESTIMONY

		Comments	
USER (UNIDENTIFIED)	PRO	NEUTRAL- SUGGESTIVE	CON
1.	<p>"We corroborate, correct, test and fill in the missing gaps, by flights scheduled by NASA Wallops."</p> <p>"The 1973 land use inventory was based almost exclusively on photography acquired by NASA."</p> <p>"A non-scientific but valuable use is the effect a NASA picture has on the public."</p> <p>". . . on a new project my first step is to pull out the NASA imagery . . ."</p> <p>". . . NASA imagery is very important to our office. We couldn't afford to do the work ourselves . . . haven't the personnel, expertise or money. . ."</p>		
2.	<p>". . .infrared imagery is very useful as a historical record for displaying changes and effects . . ."</p> <p>". . .we don't have the time or the money to do the job without imagery. . ."</p>		<p>". . .in the past our group has not recognized remote sensing as a tool. I've asked my superiors for permission to hold a regional, perhaps national, seminar on it. . ."</p>

TABLE 5. USER TESTIMONY

		Comments	
USER (UNIDENTIFIED)	PRO	NEUTRAL- SUGGESTIVE	CON
3.	<p>"...we feel the compelling utility of NASA data to our researchers should be known . . ."</p> <p>"...the use of imagery provides the only realistic way to conduct our studies . . ."</p> <p>"The data bank set-up at Wallops is good. . ."</p>	<p>"...if Wallops desires feed-back, arrangements should be made more formally. . ."</p> <p>"...Wallops is right, they shouldn't set up a board of experts. . ."</p>	<p>"Wallops doesn't communicate well with investigators."</p>
4.	<p>"...remote sensing imagery is important in making management decisions and for periodic surveillance. . ."</p>		<p>"...sometimes the NASA imagery isn't specific enough for our purpose. . ."</p>
5.	<p>"...we couldn't get the information any other way unless we traveled there ourselves. We just couldn't do that. Besides, it isn't our job. . ."</p> <p>"...without NASA we'd have to resort to commercial flights or to our own library of aerial photos, which is terrible. . ."</p> <p>"...due to NASA, I now have a better picture and broader understanding of the Chesapeake Bay. . ."</p> <p>"...maybe the very concept of an Environmental Atlas came to our minds while we were studying NASA imagery. . ."</p>		

TABLE 5. USER TESTIMONY

USER (UNIDENTIFIED)	COMMENTS		
	PRO	NEUTRAL- SUGGESTIVE	CON
5.	(cont'd) "...We would be doing a lot less if we didn't have NASA imagery. It has allowed our department to use much less time in this work. . ."		
	"...NASA imagery is vital to the development of our research activities. . ."		
6.	"...if our department had conducted the survey, the plants would have been dead before the results were compiled. . ."	"...it would be great if NASA could develop the signatures and plot the info directly on a map or produce an automatic print-out. It was very laborious for us to examine the rolls of imagery and plot the info on maps. . ."	
7.	"...if we order NASA imagery, for the first time we'll obtain the information we need. . ."		(This user has never ordered any data from NASA because of costs and "red tape.")
	"I don't believe the private remote sensing companies do as good a job as NASA--they haven't the highly developed equipment. . ."		

TABLE 5. USER TESTIMONY

		COMMENTS	
USER (UNIDENTIFIED)	PRO	NEUTRAL- SUGGESTIVE	CON
7.	(cont'd) "...the imagery of NASA Wallops is superior to that of NASA Houston--it's clearer. . ."	"NASA is beginning to put the squeeze on its own cooperators to get off on their own, but so far the states aren't responding. It's incumbent on NASA to continue its support. . ."	"...certain failures of remote sensing to live up to expectations in the past have left a sour taste in some mouths (because the) abilities of remote sensing were over-stated."
		"I recommend that NASA number its film strips in sequence along the margins."	
8.	"...obtaining data by surface investigation would require me to visit areas which are dangerous to life and limb."		
9.	"Entire new areas of research are being opened by this modern technology. Dramatic advances may occur. . ."	"...a course in data use should be implemented at Wallops . . ."	"Many investigators in the early days of spectral signature work were too optimistic--this caused much disappointment. . ."

TABLE 5. USER TESTIMONY

		COMMENTS	
USER (UNIDENTIFIED)	PRO	NEUTRAL- SUGGESTIVE	CON
10.		<p>". . .the accessibility of a multi-spectral scanner (at NASA Wallops) would be important to me."</p> <p>"I devoutly hope that Wallops doesn't tell its users, 'Okay, we've shown you how it can be done. Go out and hire a private firm to carry on your future work.' The states will always be too poor to hire private firms. If the service is in the public benefit, NASA should continue it."</p>	
11.	<p>"The NASA people gave me their generous and courteous cooperation."</p>		
12.	<p>". . .Wallops infrared imagery is excellent for providing background info about issues and problems connected with planning. I often go to Wallops for aid and advice. Otherwise, I just couldn't accomplish these things because of time, distance and authorization. . ."</p>		

TABLE 5. USER TESTIMONY

COMMENTS			
USER (UNIDENTIFIED)	PRO	NEUTRAL- SUGGESTIVE	CON
13.		<p>"I don't think that NASA should compete with private firms. I would not like to see NASA get involved with projects that are the domain of commercial companies and private enterprises. However, I suppose that a certain amount of NASA work is necessary on the research level. . ."</p>	
14.		<p>". . .in our work we would be interested in a cross-referenced index by NASA cooperative study programs by subject and investigator. . ."</p>	
15.	<p>". . .the imagery has no inherent deficiencies. . ."</p> <p>". . .when you ask me whether I think remote sensing has a future, it's like asking the Wright brothers whether flying has a future. . ."</p>		

TABLE 5. USER TESTIMONY

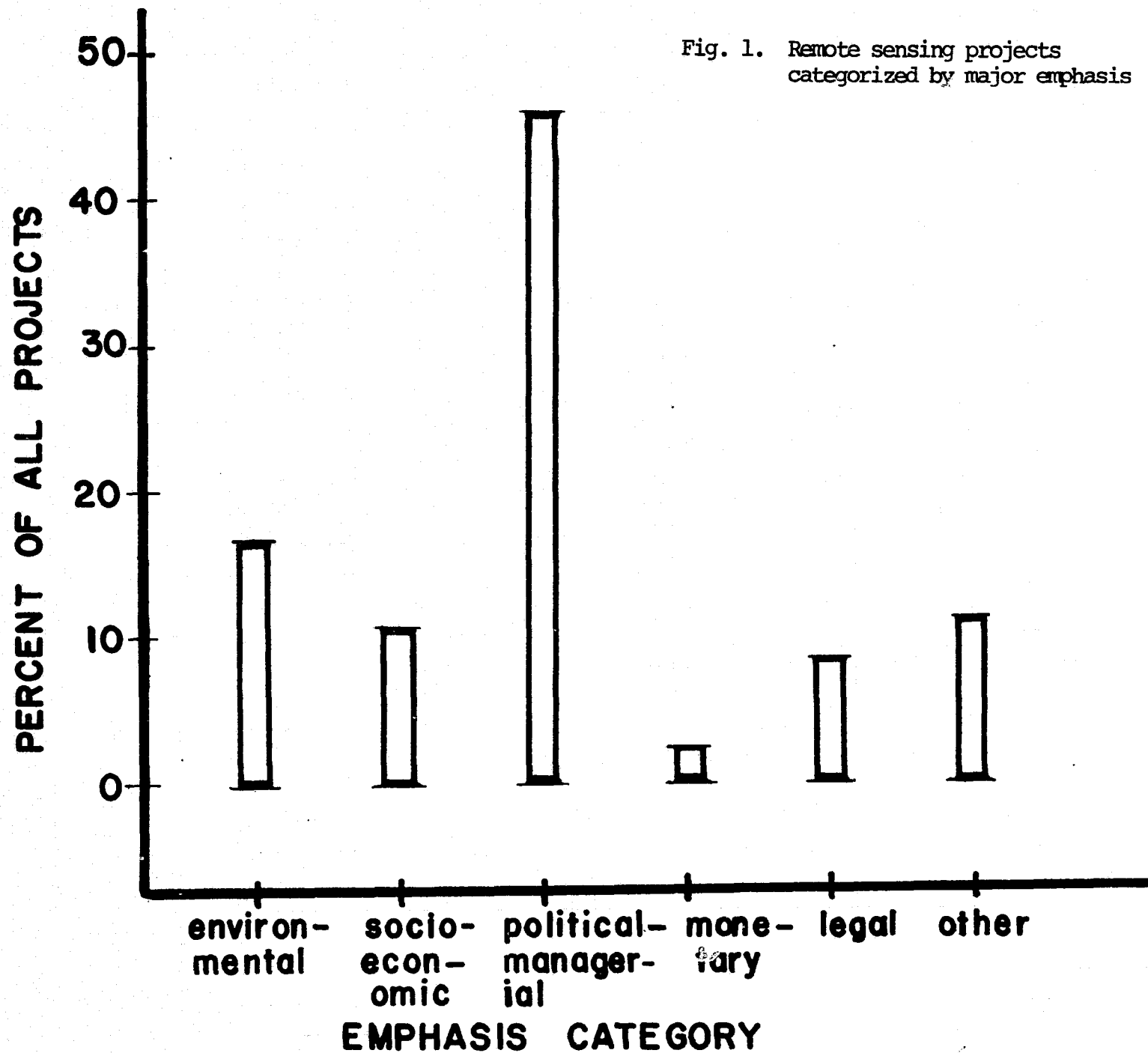
		COMMENTS	
USER (UNIDENTIFIED)	PRO	NEUTRAL- SUGGESTIVE	CON
16.	<p>"...to the NPS, remote sensing represents a 'fantastic' savings."</p> <p>"...the cost-benefit ratio of remote sensing is enormously in our--the user's--favor. I've often thought that NASA could pay for the whole space program just through the benefits that its users derive."</p> <p>"...our use of remote sensing is to obtain information that can be used by men on the lowest rungs of the management ladder..."</p>	<p>"...yes, I know that the smaller users...plead that they don't have the money to pay for remote sensing. I think they should take another look. Maybe they can't afford not to use remote sensing."</p>	
17.	<p>"...what Dr. Hammerschlag is doing on Dutch Elm Disease is 'fantastic.' If we could take these methods and use them out in the 'boondocks', it would be great..."</p>	<p>"...our personnel are not trained in aerial photography. To work in remote sensing, our people need to be trained."</p> <p>"...a training program at Wallops is what we need. Someone should go over there and find out about things, and come back and explain to us--simply--in simple language..."</p>	

TABLE 5. USER TESTIMONY

COMMENTS			
USER (UNIDENTIFIED)	PRO	NEUTRAL- SUGGESTIVE	CON
18.	" . . .more state and federal agencies should be using NASA imagery. More kids in the colleges and universities could be using NASA imagery for research and thesis work. . ."	" . . .there should be more use of the imagery already available."	
19.			" . . .what was needed was a better appreciation by the NASA people that state staffs aren't equipped to work with an outfit like NASA. Maybe NASA should create a liaison group to bridge the communication gap. . ."
20.	" . . .I can make nothing but complimentary comments about the service and cooperation of the Wallops Ecology program. . ."		" . . .what you might call a 'shortcoming' of Wallops remote sensing services is the unavailability to users of original photographs. Copies are provided but the copies sometimes don't yield enough details."

TABLE 5. USER TESTIMONY

		COMMENTS	
USER (UNIDENTIFIED)	PRO	NEUTRAL- SUGGESTIVE	CON
21.	" . . . NASA is one of the few providers in the whole world of archival information. NASA is almost unique as an impartial acquirer of information. . . ."		
22.	" . . . Is remote sensing cost effective? Perhaps it hasn't been in every case in the past, but it will be in time to come. The users of remote sensing in the future will know intuitively that remote sensing has a cost benefit."	" . . . I'm afraid that if NASA abandons their remote sensing programs at this time, under the assumption that the research and development phase has been completed, the university students of today and of the future will never receive training in remote sensing."	
23.	" . . . I feel strongly about the remote sensing program at NASA Wallops. The program's continuation is a worthwhile question. I would be willing to come down there--to Washington or wherever--to testify on the matter."		



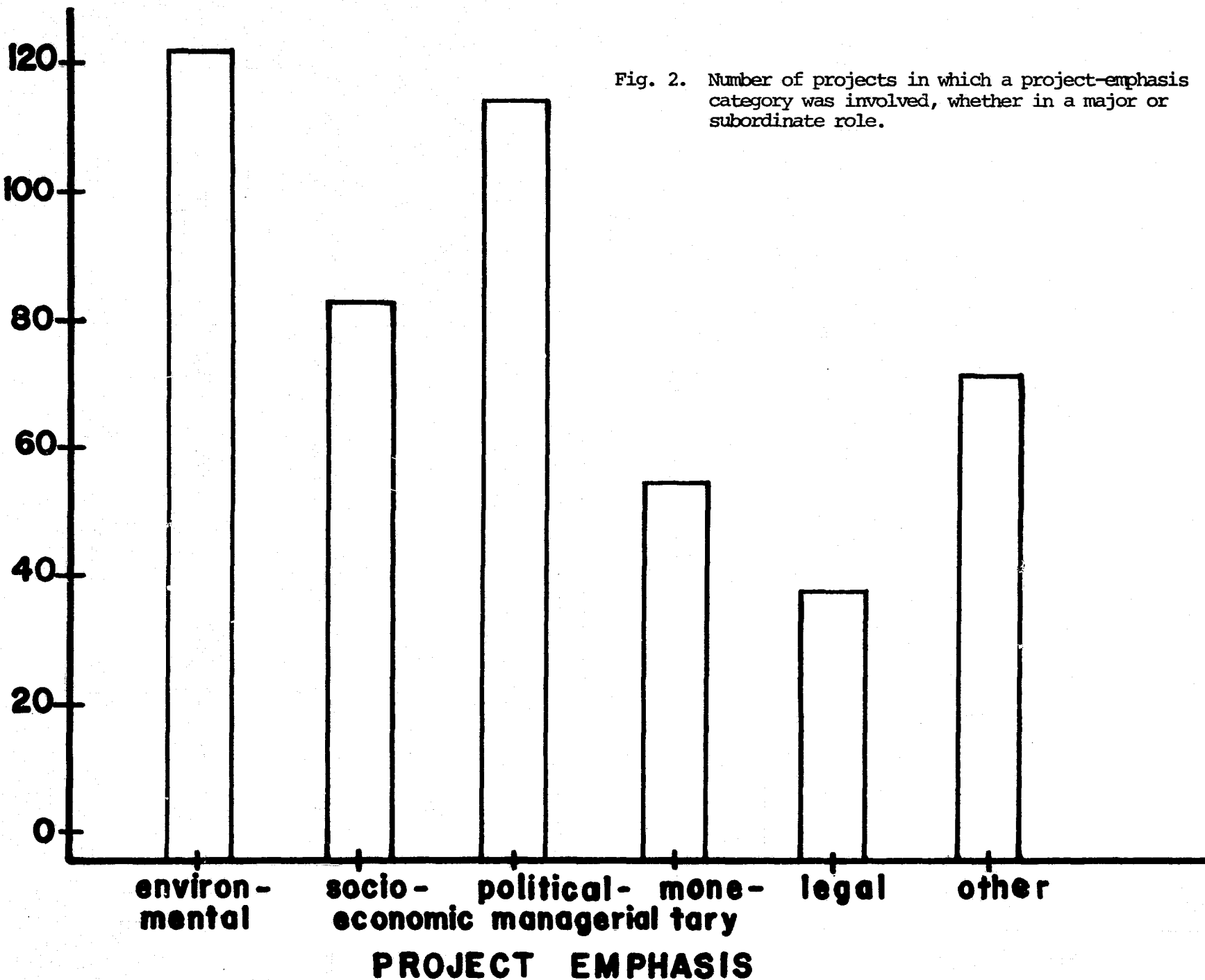
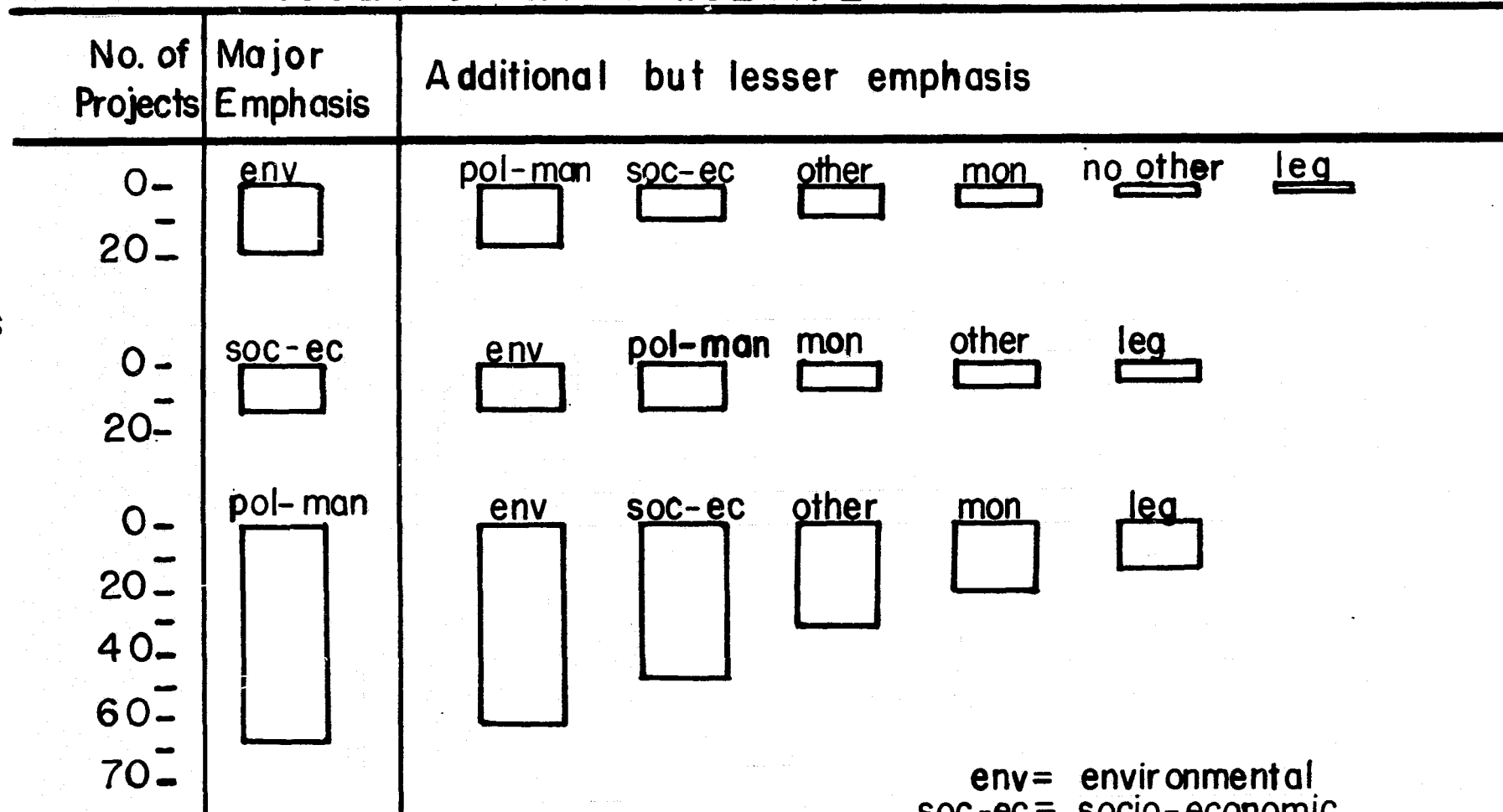


Fig. 2. Number of projects in which a project-emphasis category was involved, whether in a major or subordinate role.

Fig. 3. Analysis of association between major and secondary emphases in projects.

PROJECTS WITH MULTIPLE EMPHASIS



env= environmental
 soc-ec= socio-economic
 pol-man= political-managerial
 mon= monetary
 leg= legal

Fig. 3 (cont'd)

No. of
ProjectsMajor
Emphasis

Additional but lesser emphasis

0-

mon

env

pol-man

soc-ec

otherleg

20-

0-

leg

env

pol-man

soc-ec

monother

20-

0-

other

env

mon

soc-ec

pol-manlegno
other

20-

Fig. 4. Breakdown of NASA Wallops remote sensing projects according to the type of resource management involved.

<u>PERCENT OF ALL PROJECTS</u>	<u>MAJOR PROJECT CATEGORIES</u>
15.4	A- Land Use
12.5	B- Public Health and Pollution
1.5	C- Fisheries and Wildlife
12.5	D- Agriculture and Forestry
42.6	E- Wetlands and Coastal
3.7	F- Geomorphic Studies
3.7	G- Archeological or Miscellaneous
8.1	H- Resource Inventories

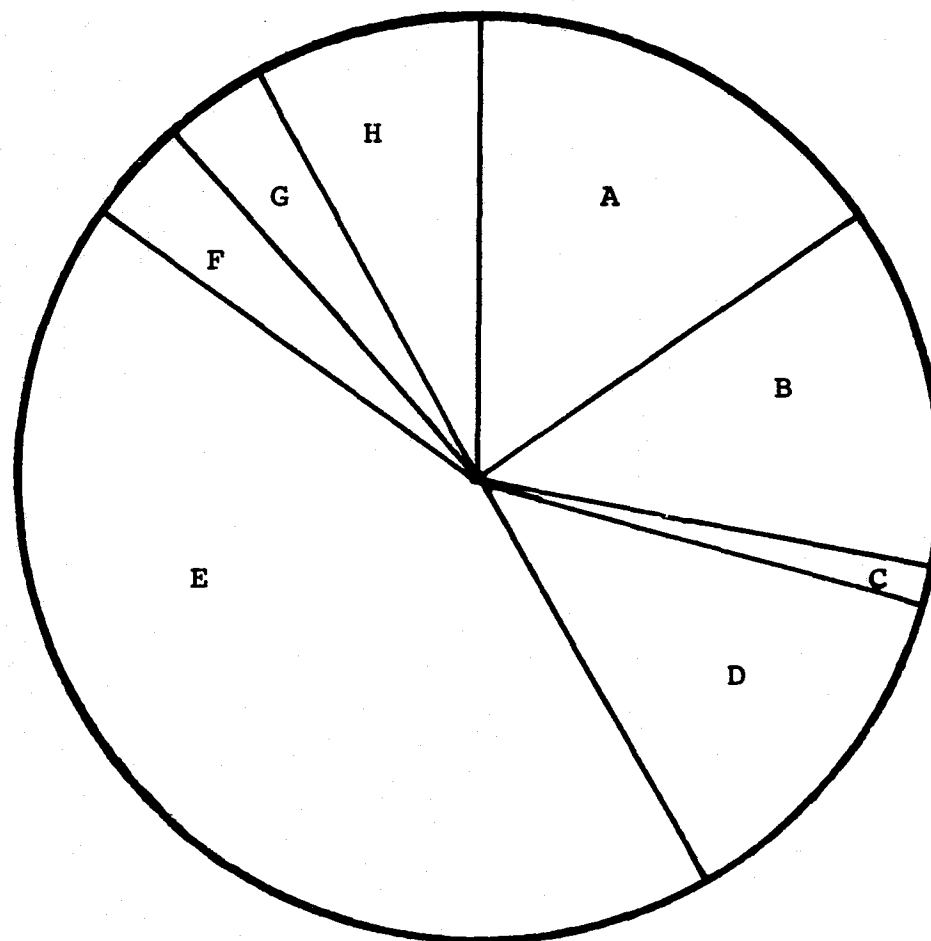


Fig. 5. Comparison of the cost and effectiveness of alternate methods with the cost and effectiveness of remote sensing.

Completed projects with monetary significance in which NASA-Wallops imagery was used

1. Hampton Roads, Va., application for fill permit
2. Location of Marriot Amusement Park
3. Oil spill, Leonardtown, Maryland
4. Request for permit for oil development
5. Ocean City shoreline development
6. Effects of storm on Hart-Miller Island
7. Strip mining
8. Geological lineaments
9. Delaware wetlands
10. Extending agricultural base—Chesapeake Bay agricultural experiment station
11. Formation dynamics of N.C. salt marshes
12. Pine bark beetle project
13. Assessing storm damage
14. Court prosecution of permit violations, U. S. Army Corps of Engineers
15. Frontalure and cacodylic acid experiments
16. Beetle control program, Cumberland State Forest
17. Cape Hatteras studies
18. Dune stabilization and beach nourishment
19. Effects of major storms
20. Tree inoculation and urban vegetation stress studies

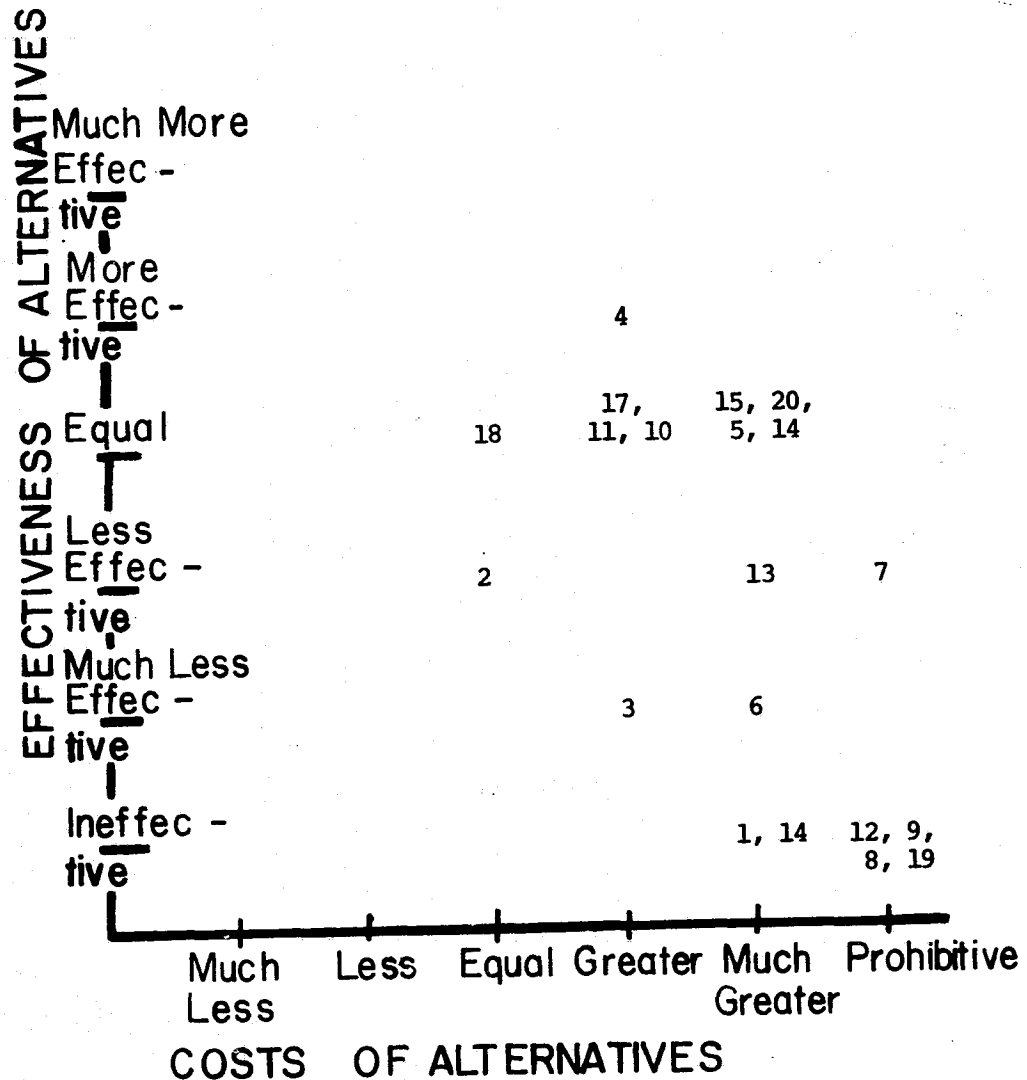
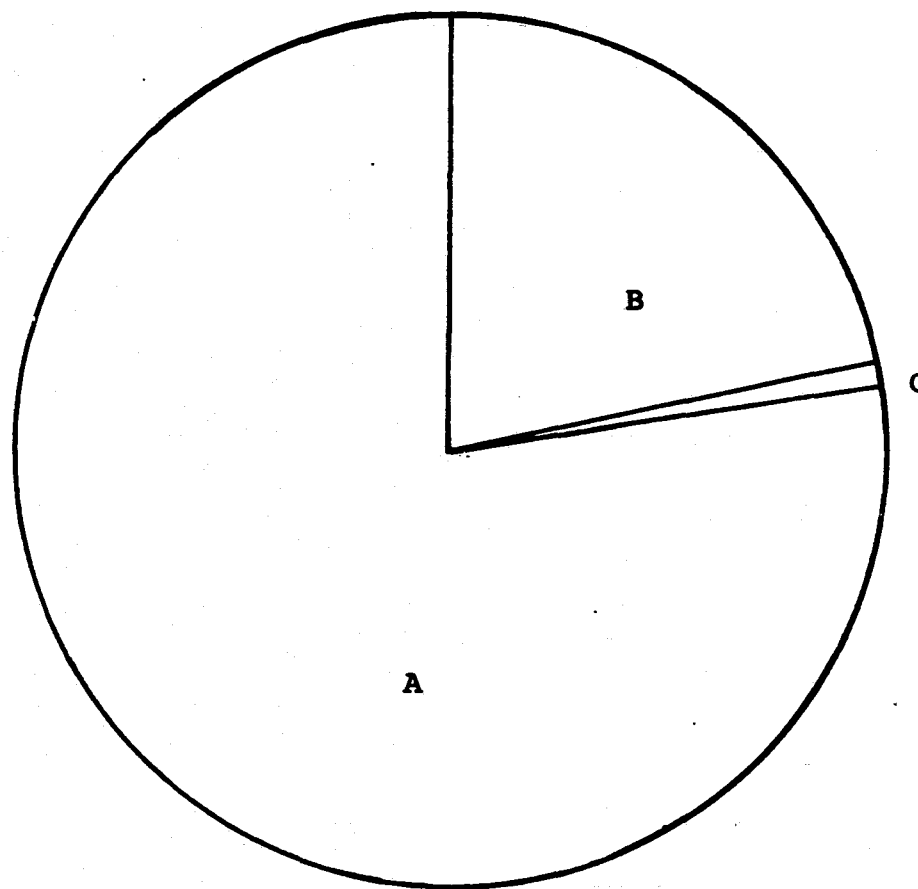


Fig. 6. Comparative dollar values for selected categorized projects in which NASA -
Wallops imagery was utilized 1/

A RECREATIONAL WILDLIFE
\$ 6, 750, 000, 000

B LAND OWNERSHIP, GOVERNMENTAL
AND PRIVATE
\$ 1, 935, 750, 000

C COMMERCIAL MARINE, WILDLIFE,
AND FORESTRY
\$ 57, 999, 500

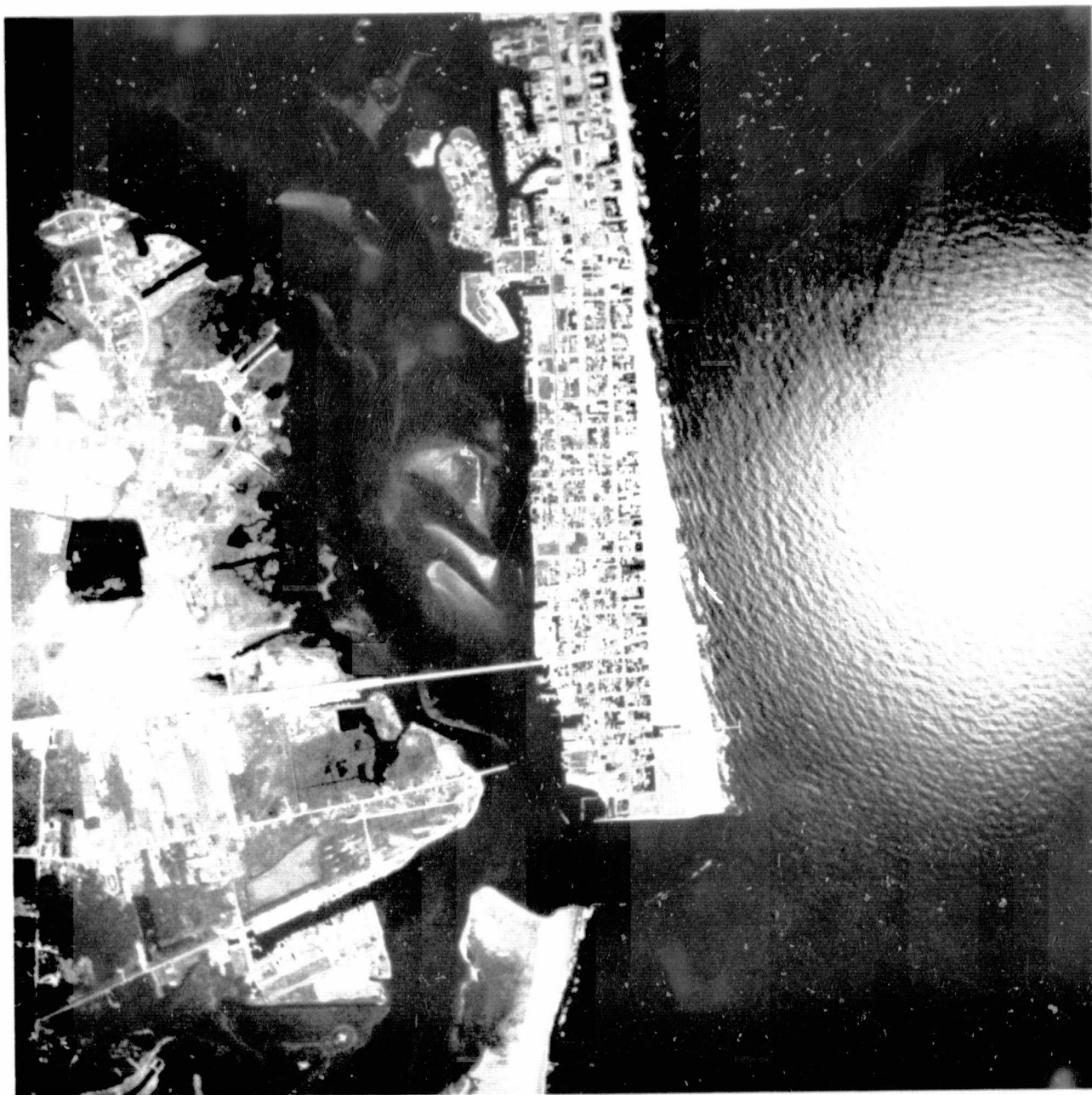


TOTAL \$ 8, 693, 749, 500

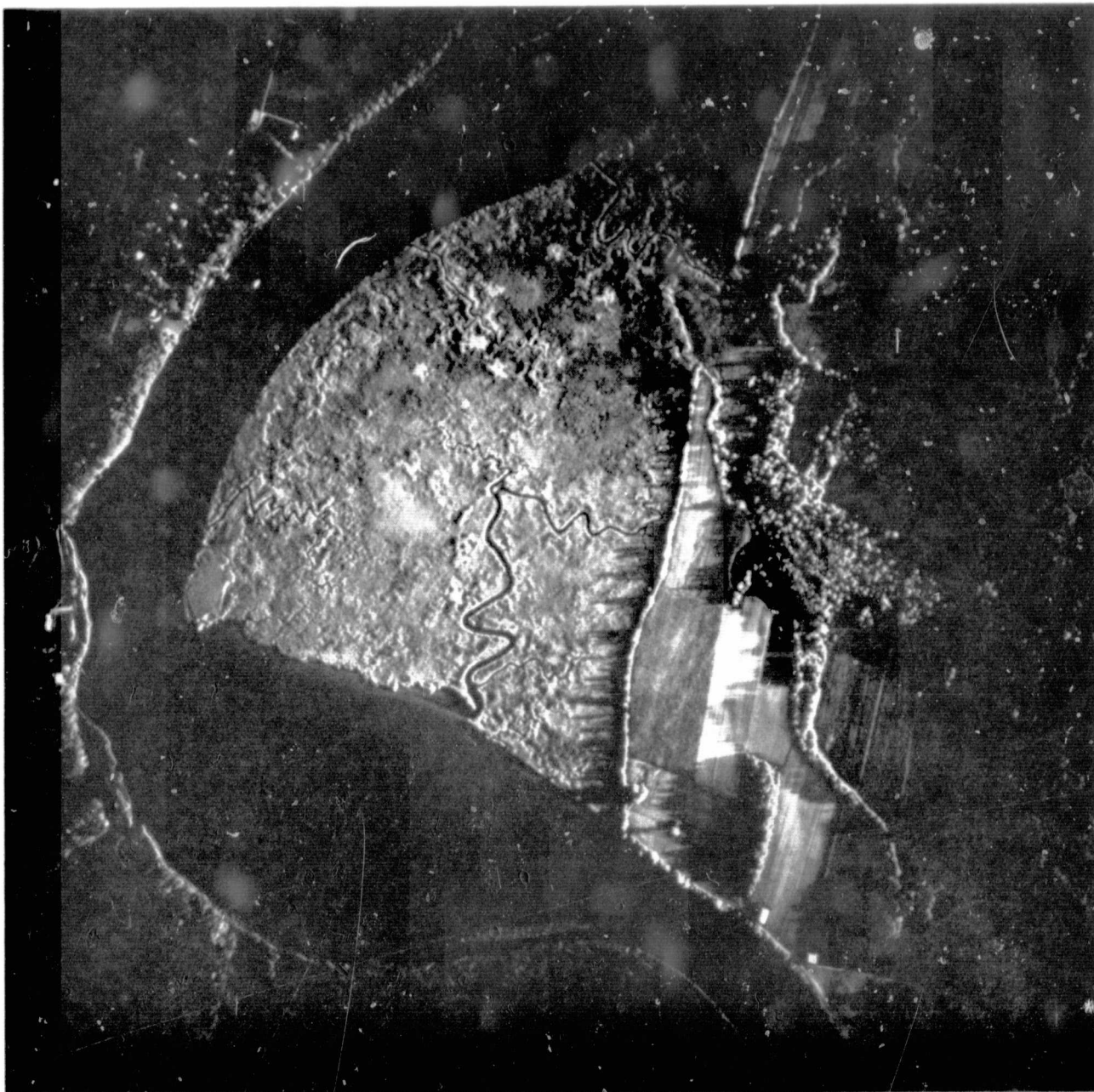
1/ Restricted to completed projects with monetary implications for which monetary data were available in the literature.

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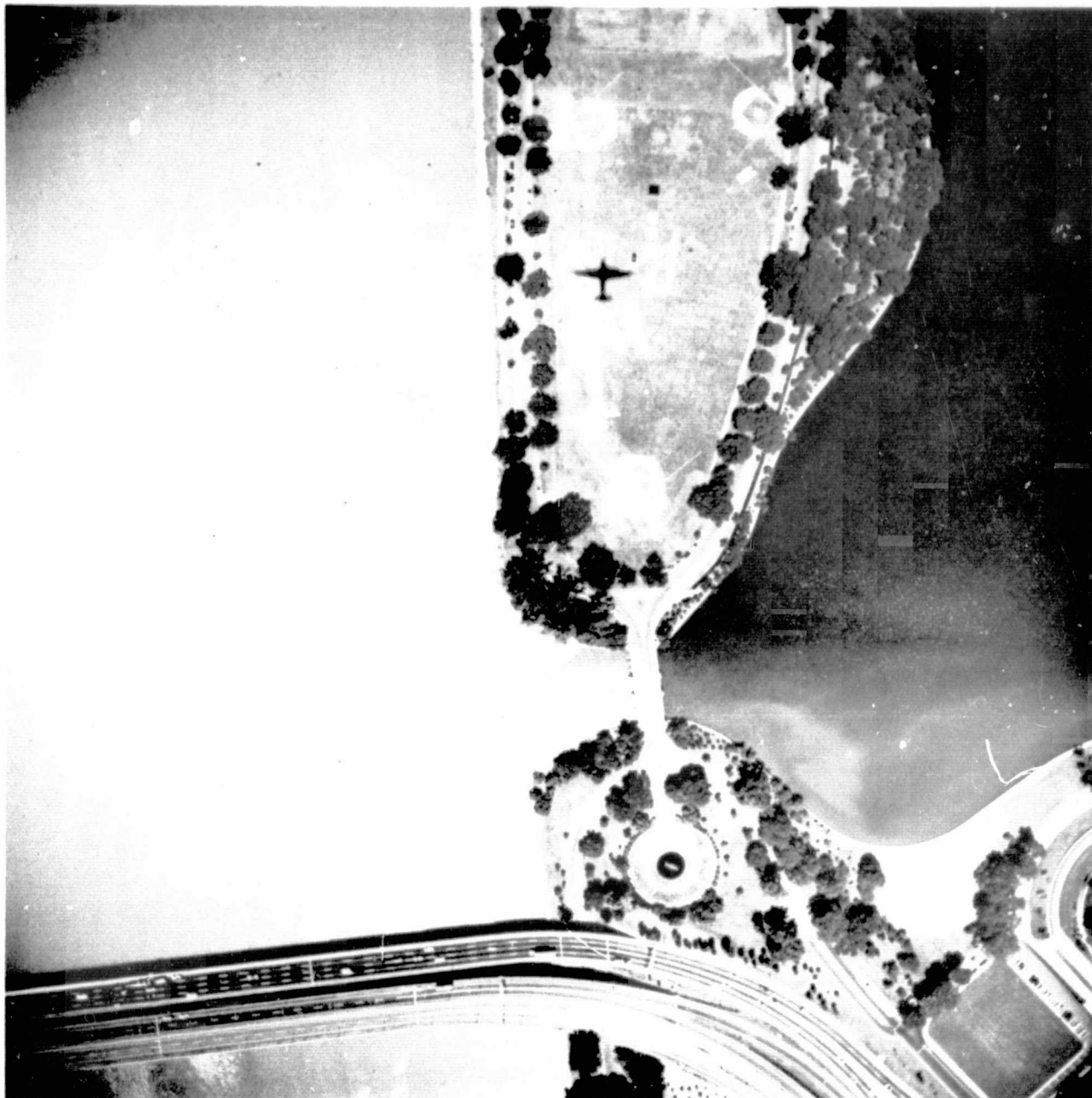
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14. Telephone conversation with Robert Lipman, real estate appraiser, Maryland Appraisers Institute, Baltimore, Md.
15. _____: Dec. 12, 1969, "Hope for Elms," Time. New York, N.Y.



Ocean City, Maryland, with Assowoman Bay to left and Atlantic Ocean to right. North tip of Assateague Island at bottom. Underwater sand bars are vividly apparent in Bay. Imagery of the Ocean City area acquired by the Chesapeake Bay Ecological Program was used for a variety of surveillance and research purposes by the U. S. Geological Survey, the Maryland Geological Survey and the University of Virginia. NASA Wallops photograph by Fairchild T-11 camera from C-54 aircraft at 10,000 feet. June 4, 1974.

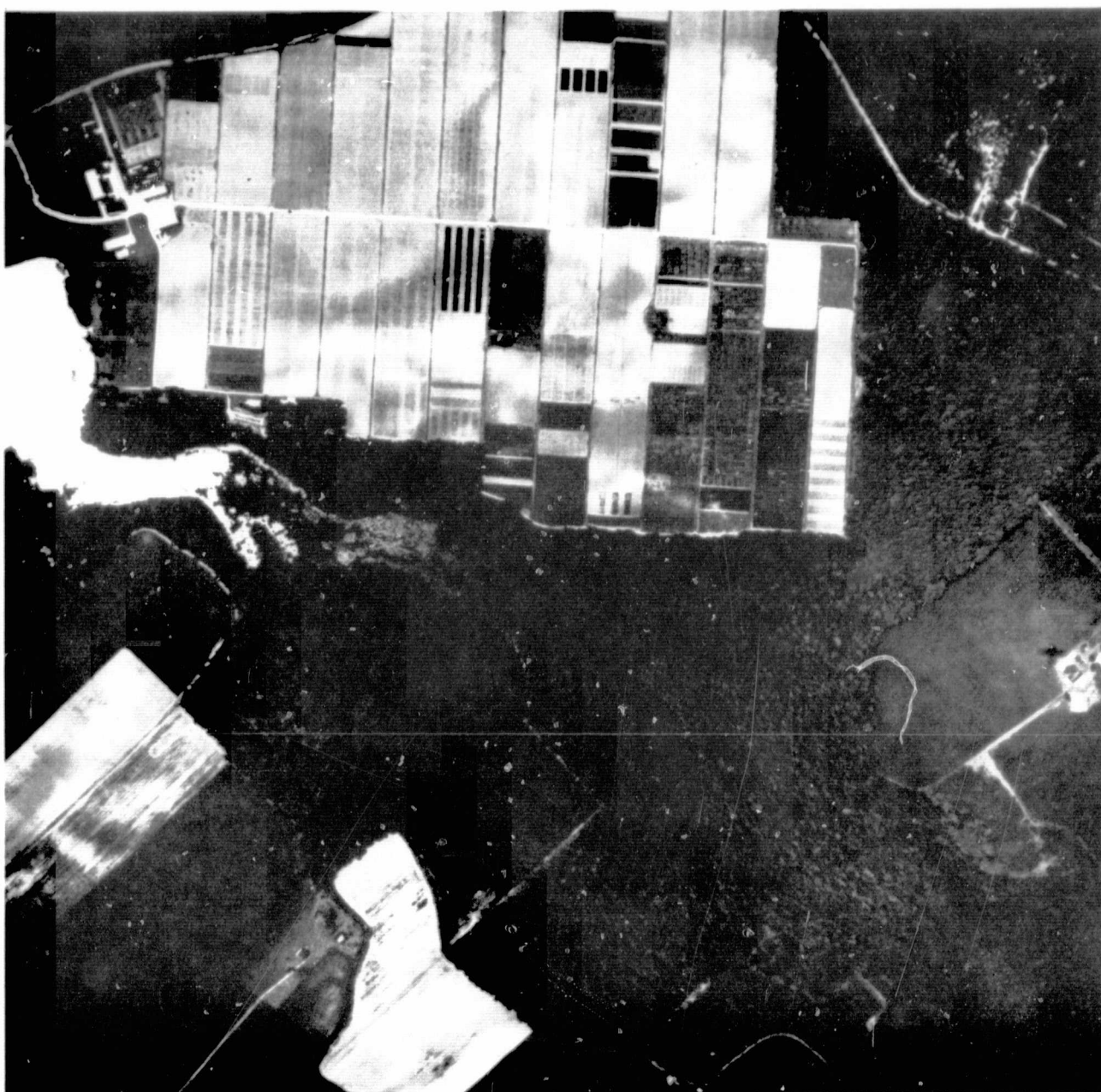


Low-vegetation wetlands along the Patuxent River which divides Maryland's Prince Georges and Calvert Counties. Upland trees to left cast long evening shadows. The Chesapeake Bay Ecological Program cooperated in wetlands studies and mapping in several states. This photograph was taken in conjunction with NASA Langley research on chlorophyll in phytoplankton. NASA Wallops photograph by Fairchild T-11 camera from C-54 aircraft at 4400 feet. Oct. 17, 1972.

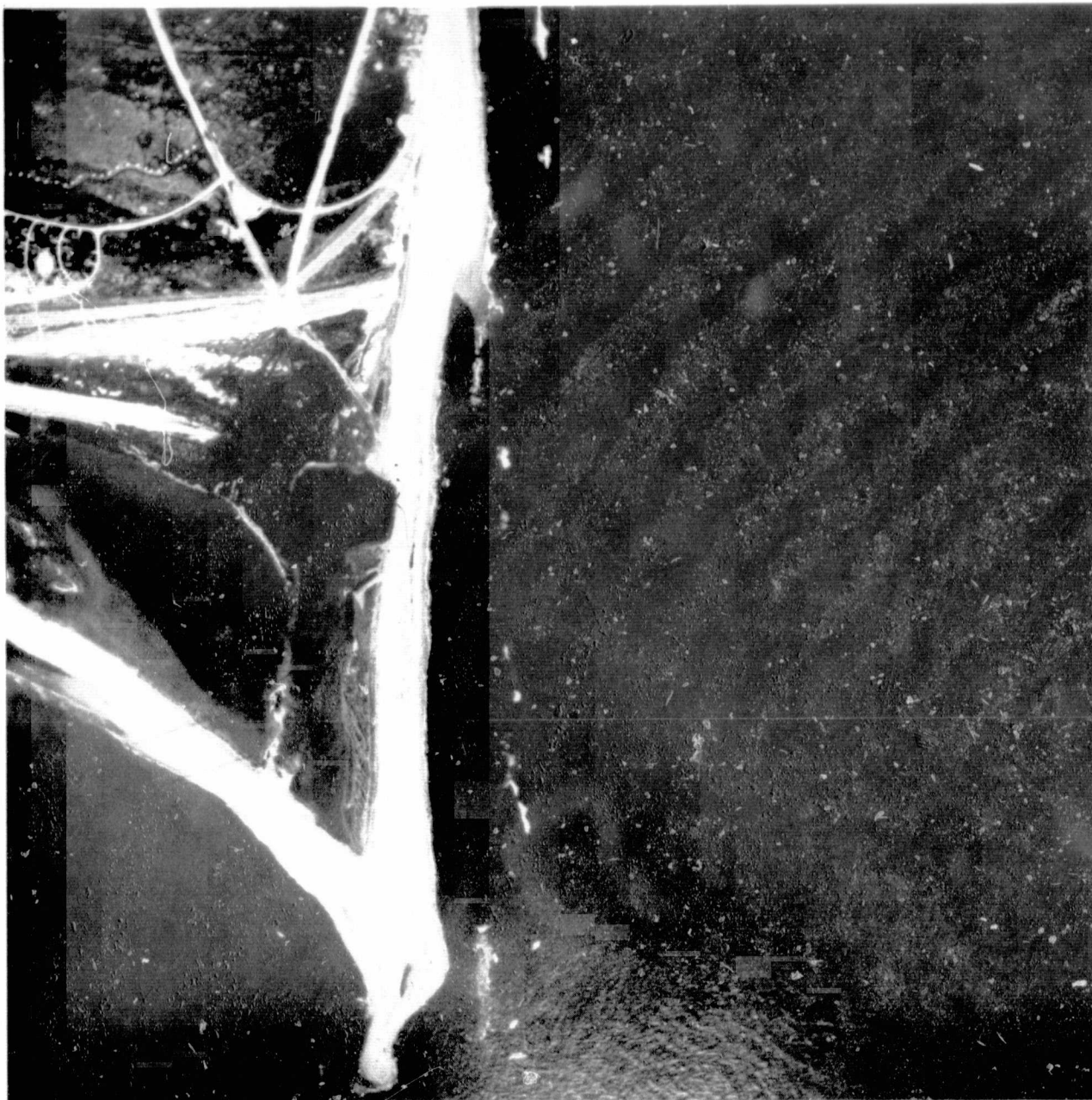


West (at top) and East Potomac Park, Washington, D. C. Tidal Basin and Jefferson Memorial to right. 14th Street Bridge carries Interstate 95 and U. S. Route 1 traffic across Potomac River. Photographic calibration panels on surface near plane's shadow. Photograph taken in conjunction with the National Park Service research on Dutch Elm Disease. NASA Wallops photograph by Fairchild T-11 camera from C-54 aircraft at 1500 feet. June 6, 1974.

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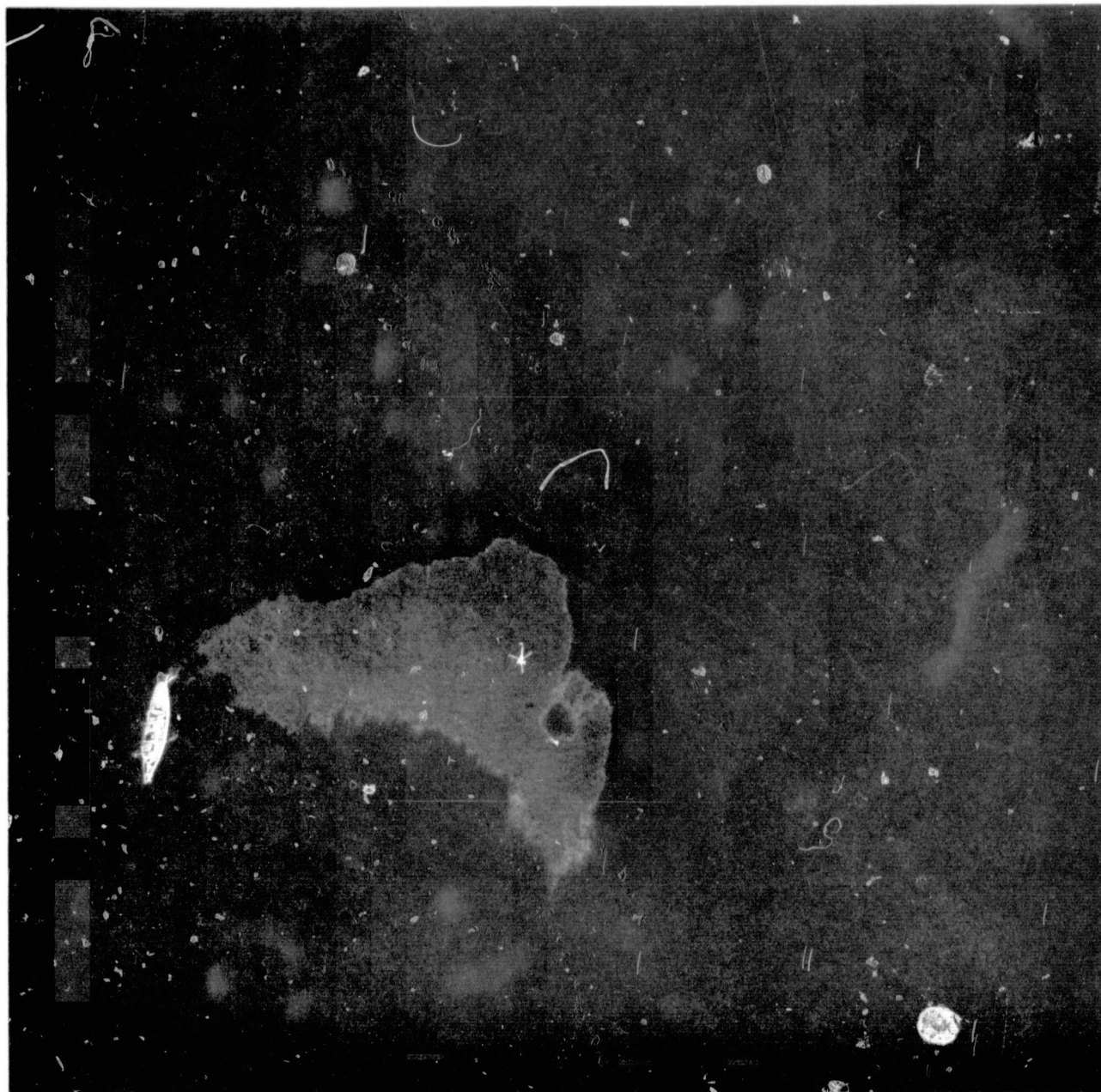


The 100-acre Virginia Truck and Ornamentals Research Station at Painter, Accomack County, Virginia. The Virginia Polytechnic Institute and State University conducted remote sensing spectral reflectance studies here in connection with vegetation and soils research. Water impoundment shows white at left border. Plane's shadow in field near right border. NASA Wallops photograph by Fairchild T-11 camera from C-54 aircraft at 3000 feet. Sept. 9, 1974.



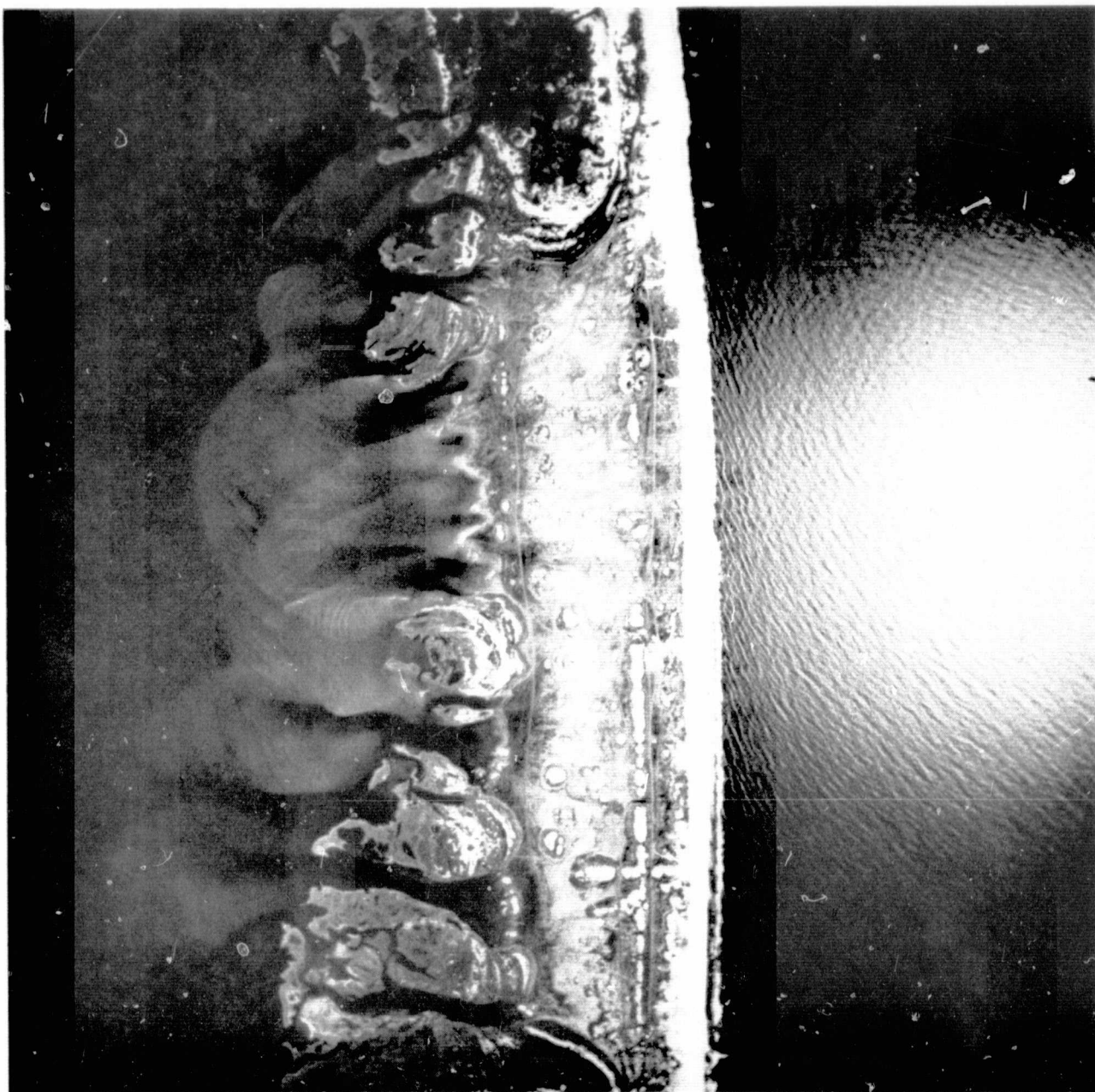
Cape Hatteras, North Carolina. Site of National Park Service studies conducted by the University of Virginia on the feasibility of shoreline protection projects. Breaking waves show up white 3/4-inch to right of beach edge. Pond at middle left was excavated to obtain sand for augmenting shoreline. Undulating series of light dots at upper left are spoil piles from drainage ditch construction. Large "V" is created by roads converging from the top. NASA Wallops photograph by Fairchild T-11 camera from C-54 aircraft at 5500 feet. Jan. 18, 1973.

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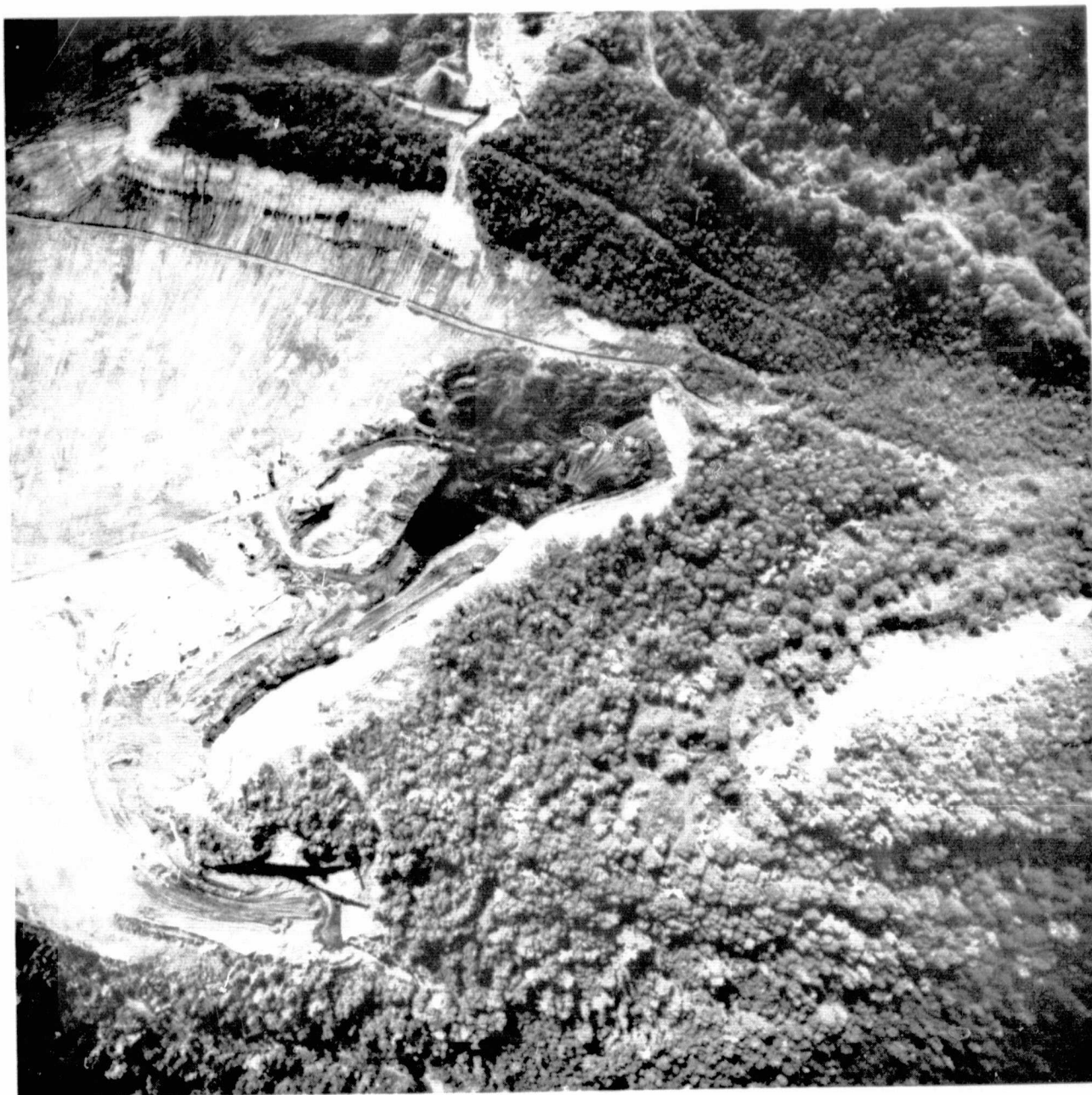
Experimental oil slick in Atlantic Ocean off Cape Charles, Virginia. Naval Research Laboratory conducted microwave radiometry study of thickness and dispersal of oil slicks. Low-flying helicopter is attempting to break up slick with prop wash. NASA Wallops photograph by Fairchild T-11 camera from C-54 aircraft at 1500 feet. May 8, 1973.

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Barrier island overwash at Assateague Island, Virginia. Chincoteague Bay to left and Atlantic Ocean to right. Alluvial sand patterns in Bay were deposited during recent major storm. The Marine Science Consortium and the University of Virginia are among academic institutions conducting research on coastal processes in cooperation with the Chesapeake Bay Ecological Program. NASA Wallops photograph by Fairchild T-11 camera from C-54 aircraft at 10,000 feet. June 4, 1971.

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Large strip mining operation in mountains of Garrett County, Maryland. Coal seam is seen as dark band 3/4-inch above road at upper left. Backfilled and seeded area at left below road. Photograph taken to monitor reclamation projects as part of joint study by Maryland Bureau of Mines and Goddard Space Flight Center. NASA Wallops photograph by Fairchild T-11 camera from C-54 aircraft at 10,000 feet. Oct. 12, 1973.

STUDY OF REMOTE SENSING UTILIZATION

DOCUMENTATION OF REMOTE SENSING UTILIZATION IN RESOURCE AND ENVIRONMENTAL MANAGEMENT

FEDERAL AGENCIES

U.S. Geological Survey (USGS), National Center, Reston, Va. -
Mrs. Virginia Carter and Mr. Daniel G. Anderson

Virginia Carter is a biologist with the United States Geological Survey. She has an office in the USGS National Center at Reston, Virginia. The USGS is responsible for water dynamics and mineralogical data on the national scale and provides hydrological analyses for various federal projects. Mrs. Carter's major research interest is in marshland hydrology. Her immediate supervisor is Daniel G. Anderson.

Uses of Remote Sensing--Major vegetative associations serve as a basis for classification and delineation of coastal wetlands. Mrs. Carter is involved in the following research projects in which NASA Wallops did or will assist by providing remote sensing imagery and/or aircraft flights. A study of Freshwater Wetlands along Maryland's Patuxent and Elk Rivers: The Patuxent River is located on the lower western shore of the Chesapeake Bay and the Elk River on the eastern shore. The study began as a joint endeavor of the USGS and the Department of the Chesapeake Bay Affairs (now defunct) of the Maryland Department of Natural Resources. The study was primarily an inventorying of the plant species growing in freshwater marshlands and a recording of seasonal changes. The co-investigating agencies regarded the study as a pilot study through which they could gain experience and develop techniques in remote sensing of marshlands. NASA Wallops acquired the imagery by a series of low-altitude flights over the rivers in 1971 and 1972.

The Department of Chesapeake Bay Affairs played only a small part in the

USGS cont'd.

study, and passed out of existence while the study was still in progress.

Mrs. Carter used the data from the study to prepare a paper entitled Seasonal Changes in Fresh to Moderately-brackish Tidal Marsh Vegetation in Maryland.

She retains the study's data and has made the material available to the Maryland Department of Natural Resources. Mrs. Carter plans another paper on the effects of Hurricane Agnes on a small marsh. Imagery is available at the Wallops repository. Mrs. Carter believes that some future studies may evolve from the study.

A Study of Coastal Salt Marshes on Chincoteague Bay: The study had two aspects: (a) a survey of vegetation and the changes produced by variations in the water table and (b) an investigation of the hydrology--the interplay between surface and ground water--on a seasonal basis. The imagery for the Chincoteague salt marshes study was derived by high-flying aircraft dispatched from NASA Houston. However, Mrs. Carter obtained the imagery data from NASA Wallops. To aid in the study, Mrs. Carter will request low-altitude imagery from NASA Wallops for purposes of comparison. Mrs. Carter authored a paper on the Chincoteague Study which was published in the Proceedings of the Eighth International Symposium on Remote Sensing of the Environment under the auspices of the University of Michigan.

A Study of Wooded Swamps along Maryland's Pocomoke River in Different Seasons: This study, which Mrs. Carter describes as her "most current research," is continuing. Mrs. Carter expects other agencies to become interested enough in the study to provide funds. The Soil Conservation Service, presently engaged in River Basin Studies, may be interested in an environmental assessment of rivers that have been channelized. They might also be interested because of the S.C.S. Soil Stabilization Program. Mrs. Carter believes that the Pocomoke Swamp Study should have applications to Agriculture and Sedimentation. Perhaps the State of Maryland will wish to participate in the study. According to

USGS cont'd,

Mrs. Carter, the study's data will probably assume the form of illustrative material. NASA Wallops will be requested to supply seasonal aerial photography from low to moderate altitudes.

A Comprehensive, Multi-faceted Study of the Dismal Swamp, conducted by many researchers in many scientific disciplines and sponsored by four or more state and federal agencies: The project is a co-operative program with the National Aeronautics and Space Administration. Photographs and imagery have been supplied by NASA Houston, NASA Ames and NASA Wallops, and have been retrieved by high- and low-flying aircraft and Landsat. Eight federal agencies have participated in the investigation. Funding from additional agencies is anticipated. The Dismal Swamp Study has involved, among others, NASA Goddard, the United States Fish and Wildlife Service, the Water Resources Department (Richmond Division) of the State of Virginia, the Cartographic Section of the United States Geological Survey, the Tree-ring Aging Laboratory of the United States Geological Survey and the Dismal Swamp Wildlife Refuge Station.

The Dismal Swamp comprises about 850 square kilometers (210,000 acres) of wooded swamp and forested bog crossing the Virginia-North Carolina border. Ownership of the Swamp is both private and public. It is presumed by the writer that the State of Virginia and North Carolina own portions of the Swamp. At least one lumbering company owns land in the Swamp and actively cuts timber. The Dismal Swamp Canal serves as an interior route of the federal government's Coastal Inland Waterway. The Swamp also contains a skeletal road system (at least in the more accessible sectors), a large lake and a network of drainage ditches.

The present research project on the Dismal Swamp originated with the donation of 49,000 acres to the federal government by the Union Camp Corporation (a paper manufacturer). The Nature Conservancy acted as the intercessor

USGS cont'd.

in the transferral. The donated land passed into the stewardship of the U. S. Forest Service. The Forest Service's reaction was: What shall we do with the land? Shall we drain it, develop it, build roads or manage it as a natural area? Congress resolved the Forest Service's dilemma by authorizing the Department of the Interior to conduct a comprehensive study of the Dismal Swamp and the Dismal Swamp Canal. The study was to assess the desirability and practicality of preserving the ecological, scenic, recreational, historic and other resource values, and to consider the alternatives to preservation.

The U. S. Geological Survey was called in to participate in the study. Virginia Carter of the USGS became the catalyst in the research programs. Already experienced in the techniques of studying coastal wetlands by remote sensing, she convinced the other investigators (of various disciplines) of the compelling utility of remotely sensed data in their own research.

In addition to photography and imagery from NASA aircraft and satellites, the Dismal Swamp Study made use of USGS maps and aerial photography.

NASA Wallops has worked closely with the Dismal Swamp Study. Since October 1974, Wallops has scheduled aircraft to do thermal scans of the Swamp. Wallops has also made available its terminal and lines to the Laboratory for Applications of Remote Sensing at Purdue University to the researchers for the analysis of data.

Twenty research studies are currently being conducted at the Dismal Swamp Natural Wildlife Refuge by various colleges, universities and agencies. These studies will furnish management advice to the Refuge personnel.

Virginia Carter's paper to a symposium at Old Dominion University lists five major categories of research on the Dismal Swamp:

USGS cont'd.

- (1) overall study area selection
- (2) location of intensive study areas
- (3) hydrologic studies
- (4) vegetation mapping
- (5) field studies to identify special interest areas

The USGS Tree-ring Aging Laboratory is interested in how hydrology is related to the age of the Swamp's trees. From NASA data, a map has been produced that is more detailed and inclusive than any previous one. Mrs. Carter has authored three papers and given six or more presentations on the Dismal Swamp Research Project on the basis of NASA data. In October, 1974, she issued a report on the Dismal Swamp to the U. S. Forest Service. Another of her papers was entitled Remote Sensing Applications to the Dismal Swamp.

Additional Commentary--Mr. Anderson discussed the Dismal Swamp Project and remote sensing: "People once looked on swamps as land to be drained--for agriculture, for canals, etc. The true value of wetlands is now recognized. Remote sensing is the only realistic way to investigate wetlands. It enables the researchers to watch temporal causes and effects. Remote sensing is a vehicle for communication. The Dismal Swamp data will be used to manage the wetlands. It will be used for analysis. The Swamp is too large to investigate without remote sensing."

FEDERAL AGENCIES cont'd.

Ecological Services Laboratory. National Capital Parks (NPS), National Park Service. Washington, D.C. - Dr. Richard S. Hammerschlag.

Dr. Richard S. Hammerschlag is Chief of the Ecological Services Laboratory of the National Capital Parks Region of the National Park Service. He regards his laboratory as an "urban stress laboratory." His predecessor as Chief of the Ecological Services Laboratory was Dr. Gary P. Clemons. Dr. Clemons and the National Park Service's Chief Scientist, Dr. Theodore Sudia, initiated a remote sensing study of Dutch Elm Disease in the Federal District. National Capital Parks, a region of the National Park Service, is charged with the care and preservation of all trees occupying the parks, parkways, monument grounds and lawns of federal buildings in the District of Columbia. The major shade and ornamental tree species of the District is the elm. Elms surround the Reflecting Pools, the Washington Monument; they line Constitution Avenue and grace the Ellipse and the Memorial Parkways. They are a feature embodying the beauty of a city which attracts hundreds of thousands of visitors annually. Washington's elms are under attack by the Dutch Elm Disease as are elms elsewhere. Sometimes the disease is outgrown; and sometimes, because it is a condition of the vascular tissue, the application of fungicides can arrest the progress of the disease. Ordinarily, however, affected trees die, especially if the infection reaches the tree's trunk.

The National Capital Parks is engaged in a Complete Control Program comprising: 1. sanitation, 2. development of new species, 3. use of fungicides, 4. use of insecticides and 5. beetle trapping.

The National Capital Parks authorities estimate that they manage 3,000 elm trees within the Federal District, and that to replace the elms would require an expenditure of millions of dollars. The trees receive constant surveillance;

NPS cont'd.

each is numbered and its location plotted on charts. The NCP is proud of the success of its custodial responsibility: each year it has been able to restrict elm mortality to between two and three percent.

About five years ago, the National Capital Parks entered on an accelerated program to furbish its arboreal resources in preparation for the 18-month-long celebration of America's Bicentennial. Officials believe that as many as four or five million persons will visit the city during the festivities. The events of the Bicentennial will constitute an unprecedented stimulus to the tourist industry.

Elevating the city's tree population to physical and esthetic perfection is a concern of the highest priority at National Capital Parks. The agency is ready to spend as much as \$200,000 this year just to restore and replace the sick and dying elms in time for the Bicentennial.

Use of Remote Sensing--The great value of the remote sensing study would lie in its ability to discover a way to detect diseased elms in a very early stage--before the Disease is apparent by ordinary visual observations. Early detection would permit sanitation operations to be carried out, enabling work crews to save the stricken tree and its companions.

Under Dr. Hammerschlag's project, several forms of aerial photography were investigated. The two most promising techniques proved to be (1) multi-spectral photography with object enhancement and (2) bi-band ratioing coupled with scanning microdensitometry. For practical purposes, the multi-spectral technique has the advantage of providing a readily interpretable image in a relatively short time.

The NPS Dutch Elm Disease Study is a cooperative project with the Chesapeake Bay Ecological Program Office of NASA Wallops. Wallops has provided low-level flights at 1500 feet over the federal district and near environs.

NPS cont'd.

The NPS will request more flights in connection with preparations for the Bicentennial celebration. The NPS desires one flight to be high enough to provide an image compassing all of the study's elms in one view. The NPS-Wallops project is now in its fourth year.

Dr. Hammerschlag says that the project is making progress. Early detection of diseased elms has been accomplished. Still, detection isn't yet possible at an early enough stage, and the study is continuing. The hope is that the study will be able to develop a spectral signature for affected elms in the earliest days of their infection, long before the condition is obvious to ordinary eyes.

The National Capital Parks has been inoculating elms with the disease. Pathological changes should be evident in three weeks, but so far the inoculations haven't "taken." Work is continuing.

The NCP conducts ground truth in concert with the aerial investigations. On one occasion, the Wallops Ground Truth Van equipped with the new Tele-spectroradiometer (TSR) was employed. Unfortunately, the Van's instrumentation wasn't functioning properly, and the mission was unsuccessful. (The TSR is the invention of Dr. Yost of the Spectral Data Company of Long Island, N.Y.).

The remote sensing investigation is based on detection of the chlorophyll reduction in affected elms. Dutch Elm Disease causes blockage of the tree's vascular system and results in the plant being unable to conduct water at the normal rate. Wilting ensues. The tree's temperature rises one or two degrees, and Dr. Hammerschlag thinks that this alteration may be detectable via thermal or infrared scanning techniques.

If a successful signature of diseased elms in an early stage could be derived, the technique could then be applied to detecting stress in other trees and plants. Dr. Hammerschlag feels that the techniques could be used to

NPS cont'd.

assess the effects of air pollution and foot-traffic on plants, and would be a very practical tool.

The techniques could also be used for the detection of other diseases, and to determine the degree of virulence. Since interpretation depends upon color and structure changes, the technique could be applied to other plant species as well.

A paper entitled Investigations of Remote Sensing Techniques for Early Detection of Dutch Elm Disease has been written by Dr. Hammerschlag and co-investigator, Walter J. Sopstyle, of the NASA Wallops Flight Center. The paper was presented at the Fourth Annual Remote Sensing Conference of the Aerospace Institute at the University of Tennessee (Tullahoma, Tennessee) on March 26, 1975. The authors regard the paper as a report on the state-of-the-art. The paper contains the statement: "An early plant stress system could prove useful in solving myriad other problems for the National Park Service."

Dr. Hammerschlag says that many scientists of various disciplines are working on the development of remote sensing techniques for vegetative studies, and if they are successful, many benefits will be derived from their efforts.

The seriousness of depredations by Dutch Elm Disease was recognized by the Secretary of Agriculture who designated the Disease a pest. Accordingly, the Department of Agriculture has authorized regulations of control under the Plant Quarantine Laws.

If in the course of its control program, the NCP discovers Dutch Elm Disease on private property, it customarily informs the owner. On some occasions the NCP has treated the Disease with the owner's permission.

The data from the Hammerschlag-Sopstyle study has been made available to such other agencies and organizations as the U. S. Department of Agriculture,

NPS cont'd.

the Shade Tree Group Research Station of the U. S. Forest Service (Delaware, Ohio), the University of Maine, Virginia Polytechnic Institute and State University and the Spectral Data Company, a private firm of Long Island, New York.

In Dr. Hammerschlag's opinion, the loss of elms seldom affects more than the esthetics of an area. He added, however, that in rare instances, wildlife habitats have been affected adversely. He cited the case of Theodore Roosevelt Island, an island of roughly one-half mile in size located in the Potomac River within the Federal District. The island is heavily endowed with elms which have suffered the ravages of Dutch Elm Disease to the degree that Dr. Hammerschlag compares the island's appearance to that of a military battleground. Doubtless, the habitat has been gravely affected.

NPS cont'd.

Dr. Theodore (Ted) Sudia, Chief Scientist, Office of Natural Science, National Park Service, 1100 L Street, Washington, D. C.

Dr. Theodore (Ted) Sudia is the Chief Scientist, Office of Natural Science, National Park Service. He has an office at 1100 L Street, Washington, D. C. His responsibility is to obtain the scientific information necessary to the best management of the real estate owned by the National Park Service.

Dr. Sudia says: "The annual budget of the National Park Service has increased tremendously over the last decade or so. The budget for 1975 is \$351,000,000.

"We here at the National Park Service are great consumers of information. We need information for establishing policy, for siting new construction, and for making ecological assessments. All kinds of information are necessary for compiling what we call the RBI--the Resources Basic Inventory. The RBI is of the greatest importance to us. All of our actions, decisions and policies are founded on the RBI."

When asked when the National Park Service first entered on a cooperative arrangement in remote sensing with NASA, Dr. Sudia guessed that the arrangement began in the late 1960's or early 1970's. He thought it began with EROS (Earth Resources Observation Satellite).

Dr. Sudia says: "At first, we didn't know how we should utilize remote sensing. Only a little money was available, so we had to decide how we could best use it. The decision was reached to get into remote sensing in a big way. We held a conference and drew up plans.

"NPS's first contact with Wallops came through Bob Dolan of the University of Virginia. Dr. Dolan had a contract with NPS for beach research at Cape

NPS cont'd.

Hatteras. Next, the NPS worked with Wallops through Paul Godfrey of the University of Massachusetts, through Dick Anderson of The American University, and our own Dick Hammerschlag who took over Dr. Gary Clemons' study of the vigor of urban vegetation in the District of Columbia.

"NPS awards contracts to universities to conduct research to obtain the information necessary for developing management plans and policies. We presently have five universities under contract: the University of Massachusetts, Pennsylvania State University, the University of Maryland, the University of Virginia and the University of Georgia.

"Yates Borden is our contractor at Pennsylvania State University. He's from the School of Forestry. I believe he's also a contractor for NASA Goddard.

"John Foss is our Cooperative Park Studies Unit contractor at the University of Maryland.

"The University of Georgia has been awarded an NPS contract to develop computer methods by which the NPS can assemble, process and utilize data.

"At present, the National Park Service is deeply involved with NSTL, the National Space Technology Laboratory at Bay St. Louis, Mississippi. The USGS has a big operation at Bay St. Louis, too. Other federal agencies are clustering there.

"Some of the analysis at NSTL is done by General Electric Company personnel on contract there.

"The National Park Service is interested in all kinds of imagery--from satellites, from high altitude, from low altitude. Wallops provided us low level imagery all over the City of Washington. We've used thermal scanning in many instances.

"The NPS has also used NASA Wallops for shoreline studies at various places along the Atlantic Coast. Wallops has performed the overflights. In

NPS cont'd.

many cases, the scientific interpretation of the data has been done at Wallops-- using NASA's instruments, which are superior to the instruments elsewhere.

"As another cooperative project with NASA Wallops, the NPS has a standing order with Wallops to fly the Atlantic coastline to record shoreline changes after every major storm. On the basis of the imagery acquired, we will construct a predictive model. This model is critical to the needs of management.

"You say that Benjamin Howland (Associate Director, Professional Services, National Capital Parks, NPS) isn't much into remote sensing yet. I tell you that he is. More so than he knows. And he'll be up to his neck in it before long.

"We believe in the telespectroradiometer, the TSR. That's why we bought it and gave it to NASA. We used it extensively on our studies. We used it on a study of the health of the vegetation all over the City of Washington. We used the TSR in Dick Hammerschlag's Dutch Elm Disease Study and it was a success. We'll continue using it to monitor the status of Washington's vegetation as a continuing project.

"The NPS is interested in obtaining information about the entire coastline of the Atlantic and the Gulf of Mexico. We tried to work out some arrangement with Cape Canaveral to obtain data about the Virgin Islands, but they never cooperated.

"To the National Park Service, remote sensing represents a 'fantastic' savings.

"Because the information for compiling Environmental Impact Statements has been unavailable or difficult to acquire, the progress of the National Park Service has been impeded by a \$200,000,000 backlog of construction projects. We are now getting what we have always needed--current information, continuously updated--to comply with the law on EIS's.

NPS cont'd.

"The cost/benefit ratio of remote sensing is enormously in our--the users'--favor. I've often thought that NASA could pay for the whole space program just through the benefits that its users derive.

"NASA could continue those programs which actively benefit users and still have time to carry on their research and development work.

"Yes, I know that the smaller users--like state agencies--plead that they don't have the money to pay for remote sensing. I'm not so sure. I think they can afford it. They should take another look. Maybe they can't afford not to use remote sensing.

"Right now, we're cooperating extensively with Wallops. We haven't done this in the other sections of the country. We could have done it with NASA Ames and NASA Rome. But we prefer to perfect the cooperation here. Let the realization and the need develop in the minds of the National Park Service people in the other sections. When they see what we have done here in the East in cooperation with NASA Wallops--what it is possible to do--they'll follow suit and get their own programs going. We're doing the pioneering work here--blazing the way.

"The National Park Service obtains its imagery from Sioux Falls through NSTL.

"Our use of remote sensing is to obtain information that can be used by the men on the lowest rungs of the management ladder. We want to be able to give the information to the man on the resource site, the Park Manager himself. We want to be able to go to him and say: 'Here is what you've always wanted, the right kinds of information and in the proper form. Now take it and use it and do the better type of job you've always wanted to do.'

"NPS's failure to provide data for management on the lowest level has always been a serious shortcoming. The situation was the result of never having

NPS cont'd.

enough money. But times are changing.

*Interviewer's note: Under the change in philosophy, the NPS is now allocating larger funds for acquiring information. More important, though, greater quantities and a greater variety of information are now obtainable by remote sensing. The information is of the basic type which is of the most value to the site manager.

"We believe we are finally achieving our objective of upgrading the quality of information at the bottom of the ladder. And when we improve the quality at the bottom, we are improving the quality all the way up the ladder.

"Our idea is to have a permanent NPS man stationed at Wallops--a liaison man. He would be familiar with all the NPS projects and would serve as the coordinator of NPS research with the NASA remote sensing program.

"My idea is to train the National Park Service personnel in the techniques of NASA remote sensing. These men would be instructed in what can be done by remote sensing and how it can be done.

"Somebody told us we could utilize a 35-channel scanning instrument. But we don't need that many channels. We can do good work with 11 channels.

"I believe that remote sensing is meaningless in itself. The mere acquisition of data is nothing. But when used in problems of land management, remote sensing is 'dynamite.'

"My advice is that the agencies (federal and state) should develop the receptors to receive and utilize the information that remote sensing can provide. These agencies should begin to 'tool up.'

NPS cont'd.

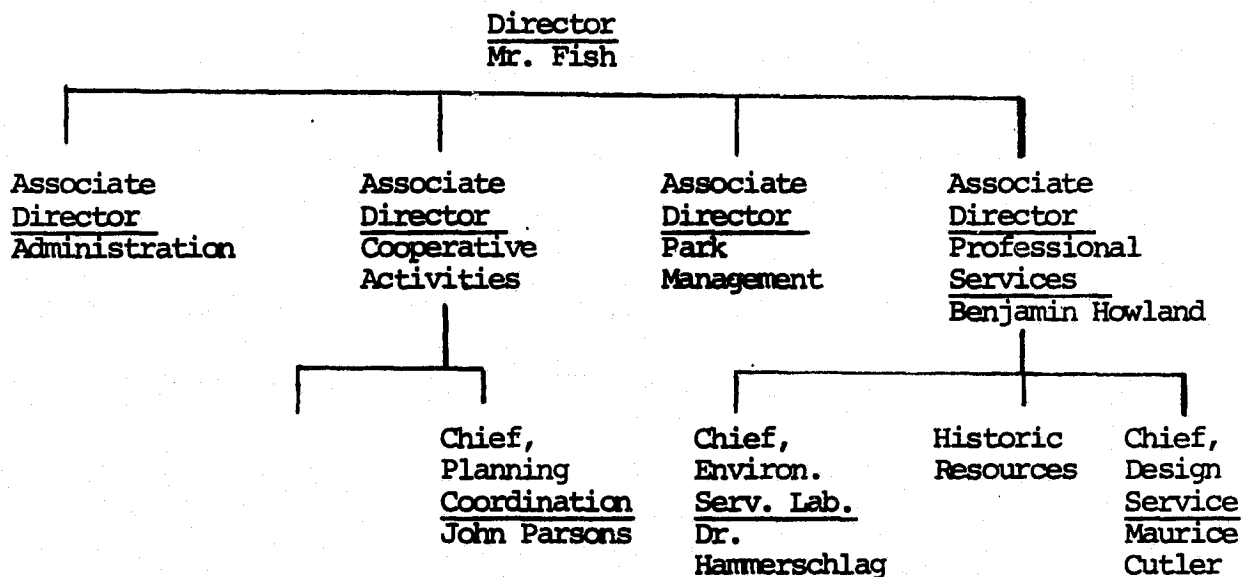
"Those who wish to use the remote sensing of NASA should realize that NASA cannot provide the complete service. The users are going to have to do their own share.

"Basically, what the NPS wants is good information, and lots of it, for managing the NPS real estate. We need this information because we are managers and we can't work in the dark.

"I'm very enthusiastic about what the National Park Service is going to be able to do with the new techniques and instruments of NASA. The data we want and need will be digitized and each separate type of information presented on a different sheet of an overlay. Even the maps themselves will be printed out automatically by the computer. We'll have all the facts we need for making management decisions about the resource on a single series of overlays. It's 'fantastic.'"

Benjamin Howland, Associate Director of Professional Services, National Capital Parks Region, National Park Service, Washington, D. C.

A diagram of the organizational structure of the National Capital Parks Region of the National Park Service:



To discuss remote sensing in cooperation with the Chesapeake Bay Ecological Program Center, the primary interviewee, Benjamin Howland, Associate Director, Professional Services, called in Maurice Cutler, Chief, Design Services, and John Parsons, Chief, Planning Coordination.

By their own admission, these men know little or nothing about remote sensing. During a major portion of the discussion, the interviewer was compelled to answer their questions about remote sensing--its methods and instruments, its capacities and the operations of NASA Wallops. Neither Mr. Howland nor the others have any definite plans to

NPS cont'd.

use remote sensing. Nevertheless, the remarks of the men are valuable for suggesting the course of the future relations between National Capital Parks and the Chesapeake Bay Ecological Program.

Benjamin Howland, Associate Director, Professional Services, has a personal interest in photography which predisposes him toward the use of remote sensing for the future projects of National Capital Parks. Howland worked in reconnaissance during World War II service in the U. S. Marine Corps. He carries out the planning duties of his office at National Capital Parks by reconnaissance. Photography is his hobby and he is currently enrolled in a night course in photography.

The relationship between NASA and the National Park Service began in 1970 when NPS became a cooperative investigating agency under the Earth Resources Technology Satellite (ERTS) Program.

Howland discussed with the interviewer possible future applications of NASA remote sensing to projects of National Capital Parks. He mentioned Karl Strandberg who is seeking funds from the Park Service for archaeological research at Fort Frederick (Washington County, Maryland) and for identifying ancient fish traps on the Potomac River.

Strandberg is an acquaintance of a Mr. Houyoeu who is President of a Rockville, Maryland, company named Aero-Photos. The company carries out aerial flights from an airport at Leesburg, Virginia. Howland is deeply impressed by a new method developed by Aero-Photos for interpreting aerial photographs: investigating black and white value scales by rotating the orientation of stereo pairs.

Howland says: "Paul Alfonsi and I talked about our (NCP) plans for development in public areas--like where power lines cross roadways.

NPS cont'd.

"The things we need are new, different and long-range views of such things as canals and roads--especially if we could examine the canals and roads cross-section by cross-section, a series of cross-sections.

"What would be good for us would be composites of oblique photos that we could study by stereo viewing. Then we could better evaluate a proposed project.

"It would be helpful to us if the temperature of the water in the canal and river could be imaged.

"The National Park Service is a preservation--not an economic--organization. We don't put a building on an archaeological site if we've already recognized the site by aerial photography.

"Our personnel are not trained in aerial photography. To work in remote sensing, our people need to be trained. We're using old-fashioned methods. We need training.

"What 'Hammer' (Dr. Richard Hammerschlag) is doing on Dutch Elm Disease is 'fantastic, absolutely fantastic.' If we could take his methods and use them out in the 'boondocks,' it would be simply great."

Maurice Cutler is Chief, Design Services, National Capital Parks.

Cutler says: "Our work is with civil engineers, mechanical engineers, surveyors, electrical engineers, architects and landscape architects. We're involved with roads and traffic. We're involved with small projects, with existing facilities. We give architectural and engineering advice and we plan alterations.

"I've never even seen infrared photographs--only what I've seen on television--pictures taken from a satellite.

NPS cont'd.

"We don't use any sophisticated photography here. We use simple black and white. I guess we're primitive. The managers here should visit Wallops to learn what's what and then come back and do a 'selling job' on the high-level people.

"Environmental quality control would have a use for remote sensing from NASA."

John Parsons is Chief, Planning Coordination, National Capital Parks. His university training was in landscape architecture.

Parsons says: "My office does planning. We work with the transportation systems, the utility companies, etc. We plan and coordinate. We coordinate any planning of the National Capital Planning Commission on activities affecting the National Capital Parks.

"No, we don't site the big federal buildings in the District. We only site small buildings--in the parks. Structures like visitor centers, restrooms, things like that. We only put up one building every five years--something like that.

"Right now, my office is interested in determining the boundaries of the Chesapeake and Ohio Canal National Historical Park. We especially want to know about the last eight miles near the Cumberland (Maryland) terminus. The only photography of the area we now have is low-level stuff taken from a Cessna or some other light plane.

"National Capital Parks has responsibility for parks other than those in the District. We're responsible for parks in the nearby states: Prince William Park (Triangle, Virginia), Ft. McHenry (Baltimore, Maryland), Ft. Frederick (Clear Springs, Maryland), Catoctin National Park and Camp David (Thurmont, Maryland) and Rock Creek Park.

FEDERAL AGENCIES cont'd.

U. S. Fish and Wildlife Service (USFWS) -
Marvin Moriarty

The U. S. Fish and Wildlife Service was represented in the interview by biologist Marvin Moriarty. Moriarty's office serves a portion of a region extending from Virginia to Maine and westward to Ohio. His division is known as the Division of Ecological Services. The U. S. Army Corps of Engineers is responsible for granting permits to private groups for construction and development activities pertaining to rivers, estuaries and coastal regions. A part of the permit-granting process by the U. S. Army Corps of Engineers is an environmental impact statement, in accordance with the National Environmental Policy Act of 1969. Moriarty's comments on behalf of the USFWS must be included in the environmental impact statement of the Corps. Thus, Moriarty's comments are very influential to the outcome of a permit request. Another of Moriarty's duties is the monitoring of the effects of nature and man on the various forms of animal life.

Remote sensing has been used or is intended for use in the following situations by the Division of Ecological Services.

Canals at Virginia Beach: A series of canals connecting Broad Bay with Back Bay is presently under construction. A possibility exists that the area's Cypress Swamp will be affected. NASA imagery has revealed that changes in vegetation and increased siltation in Back Bay have already occurred.

Delaware Court Cases: The USFWS was involved in nine illegal dredging and filling cases in Delaware. Imagery from NASA Wallops was intensively used in three of the cases. The dredging and filling had been done without permits and thus violated Section 10 of the 1899 Rivers and Harbors Act. None of the cases resulted in convictions due to out-of-court settlements. However, it is inferred that the illegal activities were terminated. Moriarty says that

USFWS cont'd.

NASA Wallops imagery played a major role in this success.

Residential Development at Ocean City, New Jersey: Residential development at Ocean City, New Jersey, involved illegal dredging and filling (without permit). The USFWS alerted the U. S. Army Corps of Engineers. The Corps was represented in court by the U. S. Attorney. The court case was lost because the judge ruled that the canals which had been dredged were of a non-navigable nature and did not fall under the jurisdiction of the Corps of Engineers.

Mean High Water Line: The mean high water line is critically important as a zone of demarcation in instances of violations of wetlands regulations. Elevations above this line do not fall within the wetlands purview. Biologists have determined that a certain type of easily identified vegetation, Spartina alterniflora, does not occur above this line since it requires tidal wetting twice a day for continued growth. In a quick review of imagery, observers could quickly spot activity on the shoreward side of the Spartina alterniflora growth and proceed to deal with this activity in accordance with wetlands regulations. Moriarty and his staff used NASA Wallops imagery repeatedly in this manner to detect violations of wetlands regulations.

Court Case at Chincoteague: NASA Wallops imagery was used in a court case at Chincoteague. On the southern end of Chincoteague Island, a developer conducted filling operations to construct a campground, depositing materials across the tidal guts occurring below the mean high water line. Upon request from the USFWS, Paul Alfonsi of NASA Wallops scheduled a helicopter flight for retrieving data via black and white infrared photography. The USFWS lost the case when the judge decided in favor of the developer.

Dry Dock on the James River: At Hampton Roads, Virginia, the Newport News Shipbuilding and Drydock Company applied for a permit to fill 270 acres

USFWS cont'd.

in expanding its facilities on the James River to enable it to handle the transfer and storage of liquid natural gas. The USFWS disapproved the company's dredging and the permit was refused. The company was then directed to select another dredging site somewhere in the channel of the Roads.

The selected site was near the Hampton Roads Tunnel, adjacent to Hampton Flats. The company agreed to erect a turbidity curtain (to contain sediment) while actual dredging operations were in progress. The curtain was ineffective and Moriarty observed "an unbelievable amount of turbidity" escaping past the curtain as he browsed through NASA imagery at the Wallops Flight Center.

To illustrate the potential damage of the turbidity, Moriarty explains that the clam population of the waters was endangered by the deposits of sand which fell on the creatures as a result of the dredging. Clams normally lie on the bottom and are capable of only limited locomotion. During the cold season of the year when the above-mentioned dredging was in progress, clams are especially torpid. According to Moriarty, clams can survive the deposition of as much as three millimeters of siltation, but would probably succumb to five to eight millimeters.

The USFWS recommended that dredging, even with the use of a curtain, be done only at ebb tide (as opposed to flood tide). The company was ordered to comply. Although the Virginia Institute of Marine Science (VIMS) does continuous monitoring of coastal areas, unless high-flight reconnaissance is conducted, turbidity of the waters would not be visible.

Barrier Islands: Wallops Flight Center has a large quantity of good imagery showing the changes which have occurred to the Virginia barrier islands in which the USFWS is interested. Metomkin Island, Accomack County, Virginia, is subjected, like all the other barrier islands, to the stress of wave action

USFWS cont'd.

which erodes its shoreline on the ocean side. Because the barrier islands accept the brunt of the wave action, the mainland to the west is protected. If the barrier islands should erode away, then the mainland would be subjected to the same forces.

The barrier islands have been perpetuated in the past by the accretion of material from the littoral drift. If the littoral drift should be interrupted, for whatever reason, then the barrier islands would disappear and the mainland shore would be endangered. The integrity of the barrier islands is also important for another reason: the estuary behind the barrier islands is a rich, spawning ground of marine life.

Metomkin Island is also the home and nesting grounds of the Black Skimmer, an interesting bird of coastal bays. Moriarty asserts that the USFWS does not have the time or money to do comprehensive, on-site research on the barrier islands. He now awaits imagery requested of NASA Wallops so he can do a pilot study of the barrier islands.

Alteration in Duck Diet: Eel grass is a marine herb growing in the shallow waters of sheltered bays and coves. It has been a staple in the diet of waterfowl (of the endangered Canvasback and Redhead ducks and other birds) wintering in the Chesapeake Bay.

Recently the eel grass has been disappearing and the waterfowl have been forced to change their diets. Soft-shell clams have become the primary item of the diet. The change in diet may have serious ramifications, since clams are known to contain concentrations of lead, other heavy metals, and arsenic.

The ingestion of heavy metals through a clam diet is harmful to birdlife. This fact has been proven by studies conducted at the Patuxent Migratory

USFWS cont'd.

Wildfowl Laboratory. The heavy metals would affect the breeding which occurs in the spring at high northern latitudes. The question is: how are these heavy metals getting into the Bay waters? Possibly they are being introduced at the Sparrows Point steel plant in Baltimore harbor. Moriarty, who calls estuaries "pollutant traps," is interested in using NASA imagery to discover a method for the detection of heavy metals via remote sensing.

Pesticides Via Imagery: Moriarty has also requested NASA imagery to investigate pesticides in the Chesapeake Bay estuary. Pesticides are in the Bay as a result of their agricultural use on farms. Natural drainage carries the pesticides into the Bay where they find their way into all levels of the food chain hierarchy.

Moriarty and the USFWS would like to be able to detect the pesticides by remote sensing. How the pesticides are transported in the water is of primary interest. The Service is interested in whether pesticides adhere to sand and silt droplets or to small particulate matter. If research could be done by sampling water near a highly agricultural land area, then predictive formulae could be extrapolated for use at distant points.

Mosquito Ditches: The Service must often make recommendations on applications for digging mosquito ditches. The ditches admit tidal water to the shallow pools inland where they flood and bring death to mosquito eggs and larvae. Moriarty and the Service fear the consequences of the vegetational changes which could result from the additional moisture. Any changes could be documented by NASA Wallops imagery.

Migration of Tangier Island: Tangier Island lies in the middle of Virginia's Chesapeake Bay. Like most such islands, its outline is ever-changing. The island is migrating eastwardly at the rate of 30 feet per year on the southern end and 10 feet per year on the northern end. The addition

USFWS cont'd.

of new shoreline on the east is accompanied by an equal loss of shoreline on the west. The reason for this eastward movement is a diminution of the littoral drift on the island's western side and an increase in the littoral drift on the eastern side.

Could this slowing of the littoral drift on the west be a prelude to complete cessation? If so, then the Federal Aviation Administration should abandon plans for spending \$500,000 to extend the airport into the Bay on the western side of the island, since it will eventually disappear as the victim of erosion.

Tangier Island, not long ago a forlorn and impoverished site, has recently become a focus of tourism (partly because of its celebration in a National Geographic magazine article). Visitors in private airplanes are descending upon the island in great numbers. A land developer has begun to build houses and sell lots on the south end of the island. The development is a million-dollar operation, but additional millions may be required to prevent it from eroding away.

Moriarty says that NASA imagery should be used to determine if the present behavior of the littoral drift will continue. He is desirous of using imagery to locate offshore bars and shoals, but he knows that imagery, at least certain types, does not penetrate water well.

Imagery Displays in Delaware Court: In Sussex County, Delaware, the Service detected a land developer conducting filling operations without a permit. The Service convinced the Corps of Engineers to take the developer to court. Moriarty used NASA imagery of the island, the fill and the vegetation types to prepare a graphic display which was presented in court.

The developer was not convicted, but the irrefutable evidence of Moriarty's

USFWS cont'd.

display resulted in a desist order. Since then, the Service has been exerting itself to have the developer remove the deposited material.

New Mexico Query about Imagery: In January, Don Rodgers of the USFWS office in Albuquerque, New Mexico, telephoned Moriarty to find out "if you can really tell vegetation by imagery." Rodgers is interested in studying the vegetation of the Gulf Coast. Moriarty mailed some imagery to Rodgers. Moriarty sees the incident as an indication of the growing appreciation of NASA imagery and the possibilities for its future use.

USFWS and Marsh Creation: The Service has convinced the Corps of Engineers of the feasibility and value of creating marshes. The Corps is committed to build one marsh in Maryland and another in Virginia. The sites would offer the opportunity for disposing of fill--even polluted fill. The fill would be seeded to develop vegetation. It would be a beneficial environment for benthic organisms and higher members of the marine chain. Dr. Edgar W. Garbisch, Jr., the director and founder of a private laboratory called Environmental Concern, Inc., has created several marshes under contract to the Corps of Engineers in Maryland and Virginia.

Moriarty says that remote sensing gives the USFWS a valuable, new method for assessing its problems. Moriarty says he is able to detect environmental alterations through the outstanding ability of infrared imagery to reveal conditions of stressed vegetation. He says that NASA imagery has enabled the USFWS to conduct investigations which otherwise would have been prohibitive in terms of time and money. When he enters on any new study, Moriarty asks himself whether remote sensing can be used. He calls remote sensing "a vital and valuable tool," and he recently asked his boss for permission to hold a seminar on remote sensing for USFWS personnel at the Wallops Flight Center.

FEDERAL AGENCIES cont'd.

U. S. Army Corps of Engineers, Baltimore District - Alex G. Dolgos, Environmental Assessment Specialist, Grace Building, Baltimore and Charles Streets, Baltimore, Maryland.

Alex G. Dolgos is an Environmental Assessment Specialist for the Baltimore District (Virginia, West Virginia, Maryland, Pennsylvania and Delaware) for the U. S. Army Corps of Engineers. He was trained as a wildlife biologist. He holds a Bachelor of Arts Degree in Wildlife Biology and a Master's Degree in Environmental Science. He has had previous experience in remote sensing "on the state level."

Dolgos has been using the services of the Chesapeake Bay Ecological Program at NASA Wallops for many months, and will continue to use the services periodically during the coming months and years while participating in a series of court cases arising over violations of Corps permits. Dolgos expects to require NASA's services about once a month.

Dolgos works in the Enforcement Section of the Corps' Baltimore District. The U. S. Army Corps of Engineers operates under the authority of the Rivers and Harbors Act of 1899. The attention of the Enforcement Section focuses mainly on tidal areas. The Section is charged with the surveillance of all human alterations to the natural coastal processes. Particular attention is paid to wetlands construction and to dredge and fill operations.

Dolgos' specific assignment is to determine precisely the nature and extent of alterations to the coastal environment done without a permit or done in violation of the provisions of a permit. Dolgos says that often the Corps does not learn of violations until after the alterations have been completed. On some occasions, violators have persisted even after being issued "cease-and-desist orders." When writing an official report on a permit violation,

Corps of Eng. cont'd.

Dolgos first travels to the Wallops Flight Center to examine pertinent NASA imagery.

Violations of Corps permits are prosecuted in the federal courts. In presenting the Corps' side of the argument, graphic illustrations are prepared which depict the affected areas both before and after alterations. The most cogent, historical evidence available is contained in the aerial photography libraries of such governmental agencies as the U. S. Geological Survey, the Department of Agriculture, the Soil Conservation Corps and NASA. Dolgos' opinion is that the aerial photography of NASA Wallops is the best source of information for the period from 1970 until the present. The periodicity and frequency of the reconnaissance flights of NASA Wallops are responsible for the continuous generation of imagery which is almost perfectly suited to the requirements of Dolgos. One of the reasons that NASA's infrared imagery is so valuable to Dolgos is because it reveals vegetation so vividly.

Dolgos, personally, may appear in court, accompanied by his graphic displays. The photographic evidence will be presented in concert with a textual assessment of environmental and ecological changes in the area under question.

Dolgos' primary task in developing graphic material for use in court is to prepare transparent overlays showing before-and-after views of violation sites. Customarily, Dolgos utilizes the services of the Chesapeake Bay Ecological Program by traveling to Wallops Island. There he consults the imagery files to locate relevant photographs. The photographs are then magnified, projected and traced through the use of NASA's technical equipment.

Dolgos says that the Baltimore District of the Corps of Engineers is earnest about obtaining convictions of the permit violators. Furthermore,

Corps of Eng. cont'd.

the Legal Section of the District expects to win the cases. Dolgos is equally optimistic, placing his faith in the ability of the visual evidence to convince judges and juries. He feels that the \$150 fee paid to an artist for producing the final version of each overlay is money well spent.

Dolgos is presently engaged in producing visual displays of two permit violations of major proportions: (1) at Gray's Creek, Ocean City, Maryland, and (2) along Assowoman Bay, Ocean City, Maryland. Both violations involve large-scale residential developments replete with condominiums and navigable canals. In both instances, the developers continued their operations despite cease-and-desist orders.

The magnitude of these Ocean City projects is testified to by the dimensions of the canals involved. One project features canals 2000 feet long; the other, canals 3000 feet long. Dolgos feels that, apart from their illegality, the canals present problems of water quality because their 22-foot depths place their floors beneath the level of the Bay floor and create "sump conditions."

One of the developers declares himself to be on the verge of bankruptcy, complaining that he has had \$500,000 "tied up" for two-and-a-half years because of the Corps' intervention, and that he will be destroyed financially if the court finds him guilty of violations and directs him to carry out restoration.

When Dolgos accepted his present assignment at the Corps' Baltimore District office, he was told that his job was "to clear up the old dogs"--to prosecute to conclusion permit violation cases which had languished unresolved for months and years. On appraising the situation, Dolgos decided that aerial photography offered the best avenue for carrying out his responsibilities. When he contacted the United States Geological Survey to obtain aerial photographs, he was advised to do as the USGS does--get the imagery available at NASA.

Corps of Eng. cont'd.

For a long time, Dolgos believed he was the first person from the Corps' Baltimore District to use NASA imagery. He has since learned that imagery and services of the Chesapeake Bay Ecological Program Center at NASA Wallops had been used on at least two occasions: (1) in conjunction with a Corps beach nourishment project and (2) as a source of background information by the Corps' Planning Division. Now when he needs a particular piece of imagery, Dolgos goes to Wallops Island, looks up the code number and purchases the imagery directly from Sioux Falls.

In accordance with a new attitude at the Corps of Engineers, Dolgos says that the Corps will no longer be placated by the mere exaction of fines of permit violators. Today the Corps insists on the restoration of the environment to the original condition. One of Dolgos' duties is to prepare the restoration plans, and for this work the imagery of NASA Wallops is his primary source of information.

Before Dolgos' tenure at the Baltimore District headquarters, the Corps had found it necessary to hire private firms to acquire the aerial photography needed for permit enforcement. The Corps estimated that the final form of each photographic print costs \$150.

Dolgos finds it conceivable that he might someday need to request special flights of NASA Wallops, but until now the existing imagery has always satisfied his needs.

Dolgos feels that the interests of the majority of the users of the Chesapeake Bay Ecological Program are not well served when so many high-altitude (U-2) flights are scheduled. He personally needs imagery from lower altitudes, especially in instances of small-scale permit violations. When he is forced to use high-altitude imagery, Dolgos finds that much important detail is lost in the process of "blowing up" the photograph.

Corps of Eng. cont'd.

Dolgos says that jetties and bulkheads are examples of small, surface features which can best be imaged by low-altitude aerial photography.

Dolgos freely expresses his appreciation for the valuable assistance and congenial attitudes of the personnel with whom he has worked most closely at the Chesapeake Bay Ecological Program Center. He specifically mentions Richard Dowd, Thomas Burton and Yvonne Nock.

Some quotations by Alex Dolgos:

"Even an inexperienced person could use remote sensing."

"NASA imagery is terrific for the observation of sedimentation, siltation and those kinds of things."

"Maybe infrared photography would be able to show the content of dissolved oxygen in bodies of water. Maybe something could be worked up on a research basis."

"There should be more use of the imagery already available."

"More state and federal agencies should be using NASA imagery. More kids in the colleges and universities could be using NASA imagery for research and for thesis work."

"I often come into contact with persons and agencies who are using the services of the Ecological Program at Wallops. Among those I immediately recall are Virginia Carter, Marvin Moriarty, the people at VIMS and a girl named Linda from The American University."

"It's my job to establish as accurately as possible the date when a violation started and when it stopped. Therefore, I would like to see NASA Wallops schedule a larger number of flights. And I would like to see the flights scheduled at more uniform intervals. Such scheduling is important to my work."

Corps of Eng. cont'd.

"More frequent flights during 1972-73 would have produced imagery very valuable to my present work on old permit violations. I especially need imagery acquired as close as possible to certain dates. In particular, I need imagery taken near the dates of the Corps' cease-and-desist orders."

STATE AGENCIES

Maryland Department of State Planning (MDSP), John C. Antenucci,
Land Use Planning Office.

The Maryland Department of State Planning is responsible to the Governor and the State Legislature. The Department consists of a central staff, a clearinghouse group, a research group, a capital improvements group and a local regional planning group. John Antenucci is a Natural Resources Planner in the research group which handles socio-economic data.

The Department of State Planning was created in response to the new concept of the value of land which holds that land is a resource to be used for the social, economic and physical development of a society rather than solely for the financial benefit of the owner.

Aware of the past mismanagement of land, with accompanying environmental and ecological complications, the State Legislature created a Generalized Land Use Plan under the direction of the Department of State Planning. The five basic purposes of the Plan are: (1) to provide a framework within which state and local governments can evaluate long-term land-use options; (2) to assure that Maryland's finite supply of land is most effectively managed in the best interest of the social, economic and physical well-being of the state's citizens; (3) to protect and preserve the integrity of valuable historical, cultural, ecological, recreational and esthetic resources in the state; (4) to promote the achievement of orderly development patterns which permit the provision of necessary facilities and services in such a way as to maximize the utilization of public investments; (5) to promote more humanized living, circulation, employment and public service patterns and characteristics which enhance the quality of life of the state's citizens.

MDSP cont'd.

A major effort of the MDSP is the formulation of a state land use plan, for which NASA data has been used extensively. A list of the uses follows.

Land Use Inventory by CARETS: The Department of State Planning became involved with NASA five years ago when the 1970 Land Use Inventory of Maryland was compiled by the U. S. Geological Survey. Data for the inventory was obtained through a project known as the Central Atlantic Regional Ecological Test Site (CARETS) which served as a pilot study for a variety of remotely sensed data applications by NASA and the Department of the Interior. The test site extended from central Virginia to Pennsylvania and New Jersey and included all areas of Maryland east of the Catoclin Mountains. Antenucci says that sometimes the ERTS imagery was only marginal in quality, but that tapes from the satellite were excellent. NASA Wallops' services were utilized by the MDSP through low-altitude aerial flights and ground truth excursions.

The Land Use Planning Program: In the preparation of the Land Use Planning Program, the DSP has been using NASA data from high and low altitude airplane flights scheduled by NASA Wallops to correct and test their previous data and to obtain information for filling gaps. Imagery from Wallops flights has also been used to corroborate and test the data supplied DSP by the United States Geological Survey.

Agricultural Land Inventory: Throughout the nation, large amounts of land have been passing from agricultural use into other uses. The same trend is occurring in Maryland. The concern caused by this trend has resulted in recent federal and state legislation whereby farmers are given relief in various forms to enable them to continue in agriculture. Maryland is one of the states which will provide legislative relief and the DSP has been occupied with identifying agricultural lands and changes in usage. Relief for the farmer will come in the form of a 20-year-easement program under the Department of

MDSP cont'd.

Agriculture by which subscribing farmers will receive tax benefits. The DSP will use NASA imagery in its agricultural land inventory. If NASA imagery were not available, the Department could still carry out the inventory by (1) land-rental records, (2) figures from the 10-year census and (3) farm equipment sales records.

Comprehensive Land Use Plan: The major work of the Land Use Planning Office has been to prepare a comprehensive land use plan for the state. By February, 1975, all the needed data had been collected and analyzed. Six alternative plans are being submitted for public review. Following this, one revised plan will be decided upon for implementation.

The Land Use Planning Office has used in the past and will use in the future the services of Earth Satellite Corporation of Washington, D. C., and Berkeley, California. This firm makes its own private imaging overflights, but its greatest value to the IUPO is its capacity to do analysis and produce maps. ESC did the photographic interpretation of the 1973 imagery. Antenucci says that "the state doesn't have enough personnel to do such jobs themselves, and, anyway, it couldn't attract the proper type of individual." He describes the past efforts of the corporation as "excellent."

The Department of State Planning does a new land use inventory every three to five years, for which NASA imagery might well be used. On the other hand, the inventory might be done by private contract.

Oil Spill Cases: Oil spills have occurred along America's coastline causing deep and general concern. Antenucci expects that Maryland will soon have to contend with this problem. Already his office has been involved with a court case in which a refinery was responsible for a spill. NASA imagery will be used in future oil spill cases. The oil spill court case referred to above used NASA imagery and was held at Leonardtown by Judge Powers of Upper Marlboro.

MDSP cont'd.

Piney Point Refinery: The Piney Point (St. Marys County) situation is one in which NASA imagery may become involved. Steuart Petroleum Company is asking for permission to erect an oil refinery at Piney Point. The Tri-County Council of Southern Maryland is fighting the project and has requested imagery from Wallops.

Flood Plains: The DSP is involved in matters of water quality. It is interested in the mapping of flood plains and flood-prone areas. Information and data from remote sensing imagery may be used to formulate flood plains ordinances.

Imagery and Public Health: When asked for an example of NASA imagery contributing to the public health, Antenucci cited the instance when local planners asked for Wallops imagery of Kent Island. The planners wished to discover septic tank failures and other information (e.g., vacant housing). Unfortunately, the imaging was done during the fall months when the grass, which would have normally been vividly green, was brown because of seasonal dormancy, and the imagery failed to produce what had been hoped for.

State's Surplus Land: One of the DSP's primary uses of NASA imagery is for the inventory and review of surplus land which the state owns. This information is accumulated for use by the clearinghouse division of the DSP. Antenucci says that whenever this task presents itself, his first step is to pull out and examine all the available NASA imagery. Although he could obtain the data by using his Department's computer data bank. Imagery is his preferred source because it offers an instant character summation of a locality. The imagery is effective because it depicts such cultural features as historical sites, dwellings, etc.

General Information: Another use of NASA imagery falls within what Antenucci called the general information or catch-all category. His office

MDSP cont'd.

receives a broad variety of questions, the answers to which imagery provides the quickest, most accessible and suitable methods for securing. Typical queries are: "How many historical sites lie within the area?" and "What high structures exist near the site of the proposed power plant?"

It is Antenucci's announced intention to have the Land Use Planning Office become the repository of all Maryland imagery. He is mailing letters to all local governments asking them to turn over to him all their pertinent imagery. His office is now preparing an imagery catalog which will be distributed widely so that every agency in the state can avail itself of the service.

The Marriott Amusement Park: The DSP used NASA Wallops imagery to answer a request of Governor Mandel to predict the environmental impact of the Greater American Amusement Park. The amusement park (a Marriott enterprise) was to be built between Baltimore and Washington. The county government refused to allow construction of the park and the developers decided to locate in Virginia.

Baltimore-Washington Corridor: NASA Wallops provided the imagery for the DSP's appraisal of possible routes for the Baltimore-Washington highway corridor and its northeast extension out of Baltimore. The corridor includes the transportation arteries of Routes 1, 40, 301, 29 and Interstate 95. The appraisal concerned itself with land use changes and impact.

Harford County Imagery: In consideration of future development in Harford County, a land use map of the county was prepared under contract by the Earth Satellite Corporation (Washington, D. C., and Berkeley, California) for the DSP (and financed jointly by the U. S. Department of Housing and Urban Development and the Maryland Department of State Planning) and issued in 1973.

MDSP cont'd.

In the publication manual referred to in the above paragraph are written these words: "The 1973 Land Use Inventory (of which the Harford map was one part) was based almost exclusively on photo-interpretation of high altitude aerial photography acquired by NASA. Use of collateral data was minimized in order to conserve cost and time without significantly impacting accuracy and quality."

When asked to describe the worth of NASA imagery to him and his office, Antenucci said, "It (NASA imagery) is very important. We couldn't afford to do the work ourselves, either high-level or low-level imagery. They have provided us with material that we couldn't have provided ourselves, since we haven't the personnel, the expertise or the money."

Antenucci says that Wallops imagery offers "a non-scientific but valuable use through the effect a NASA picture has on the public."

He explains that although citizens may be very familiar with a locality through frequent visits, they cannot really visualize the situation.

Antenucci says, "The true impact of (remote sensing) imagery may be soft, but it is telling." He explains that although imagery's influences may be subtle, that it is often a key factor in the resolution of a problem. He says that imagery is very useful for working with the public and with politicians.

The DSP attested to the value of its association with NASA in a publication manual of its Technical Series in May, 1974, entitled "The Land Use Classification system"--"the results of these (NASA remote sensing) programs have had a strong influence on the design and character of the Maryland land use inventories."

MDSP cont'd.

From the DSP manual, "The Land Use Classification System":

Maryland is unique in the fact that multiple aircraft flights were conducted over the State by NASA in 1972, and 1973, thereby providing multi-date photography for temporal analysis. One of the areas evaluated was the dense urban environment of Baltimore City. . . .

Aerial Photography used in the 1973 Land Use Inventory consisted entirely of high altitude color infrared images acquired by NASA. Multi-date coverage existed over several seasons and was used extensively, particularly for the detailed determination of vegetated land covers, including the agriculture, forest and wetland categories.

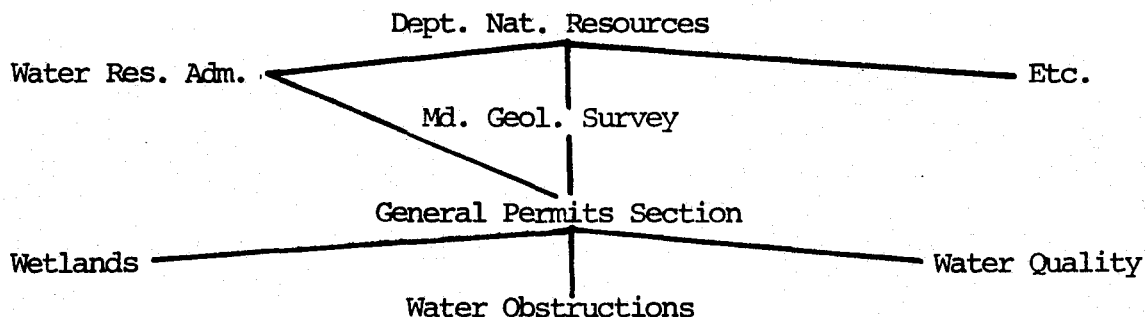
The Department of State Planning will soon have available a service called Maryland Automated Geographic Information System (MAGI). Much of the data was obtained through the ERTS program.

STATE AGENCIES cont'd.

The General Permits Section (GPS), Water Resources Administration (WRA), Maryland Department of Natural Resources--
William S. Sipple.

The General Permits Section of the Maryland Water Resources Administration is responsible for issuing wetlands permits for the regulation of dredging and filling of tidal wetlands, for certifying to federal agencies the impact of proposed projects, and for issuing permits involving surface water use, including appropriations, dams and reservoir construction and waterways and flood plains construction. The Section issues permits involving groundwater use and the construction of water wells. The Section is responsible for issuing waste discharge permits for 1,500 industrial discharges and several thousand discharges from active mines and agricultural sources. The Section also licenses all persons engaged in storage, transfer, treatment and disposition of oil.

The structure of the organization of Maryland's public agencies involved in activities of the General Permits Section is as follows:



Mr. William Sipple of the General Permits Section was interviewed concerning his use of NASA Wallops remote sensing data. Sipple said that Maryland's wetlands consist of 307,000 acres. Parcels of less than five acres are not included in this total. He said that meetings to review

GPS cont'd.

wetlands permit applications are held once a month. He estimates that 30 to 50 permits a month are processed. Sipple's duty is to determine the environmental impact of the projected activity. Sipple's purview includes not only the shores and marshes but the waters themselves, even the open portions of the Bay.

The applications are for permission to dredge, fill and develop (marinas, homes, canals, etc.). In ruling on the applications, particular attention is given to the littoral drift. Sipple characterized the WRA's use of remote sensing imagery as occurring in three phases. (1) Flights were flown to gather data via black-and-white infrared. The gray tones of the imagery were excellent for portraying the flooding of the land. In this way the Mean High Water Line, considered to be the boundary of the wetlands, could be unequivocally delineated. (2) The areas were then photographed in infrared, the purpose being to obtain additional details. (3) The areas were photographed a third time in natural color.

Groins and Jetties: Mr. Sipple stated that remote sensing imagery is important in making management decisions about shoreline structures. Groins and jetties are two types of shoreline structures. Groins are stone or concrete structures built perpendicular to the shoreline to prevent shore erosion at the site. Jetties are similar in construction but are mainly erected to maintain channels in the Bay by preventing the accumulation of sedimentation. Thus, jetties are likely to be longer and more expensive than groins.

A dispute exists among experts about the value of groins. The Md. Geological Survey believes that groins cause erosion downcurrent; conversely, the Md. Fisheries Administration favors groins because they attract fish and increase the site's capacity for supporting other marinelife. Thus, groins serve some esthetic and recreational purposes in addition to their practical

GPS cont'd.

purposes. The explanation for the groin's causing shoreline erosion down-current is that all beaches continuously lose sand. The stability of a beach depends on continuing replenishment by sand riding on the littoral drift. Groins, because they interrupt the littoral drift, are responsible for the sand deficit. The money spent on groins might be spent instead on riprap. Riprap structures are constructed parallel to the shoreline and are useful for widening the tidal zone and enhancing the habitat.

Riparian Rights: A responsibility of the Water Resources Administration is to protect the riparian rights of Maryland's citizens. Riparian rights provide that shoreline owners must be guaranteed (1) access to openwater and (2) protection against the erosion of their property. In applying for permits, an applicant might dissemble his motive. For instance, a property owner might apply for a bulkhead permit, ostensibly for forestalling erosion, while his true motive is to reclaim additional real estate.

The Water Resources Administration has an enforcement section to see that permittees are in compliance with the law and that no activity is being conducted without a permit. Periodic photography is one means of surveillance, but on-site inspections are also conducted. In actual fact, the enforcement authorities often learn of violations through citizen informants.

Smithsonian Vegetation Mapping: Dr. Barbara Rice of the Chesapeake Bay Center for Environmental Studies of the Smithsonian Institution produced vegetation maps of marshland units in Anne Arundel County. Sipple borrowed these maps to plot the information on the WRA's wetlands maps. The additional data were valuable to the WRA for reviewing wetlands cases. A letter from Sipple to Rice relates that the WRA used the Smithsonian maps in court for a private wetlands case. Dr. Rice's work was based on NASA remote sensing imagery.

GPS cont'd.

Chesapeake Bay Dredging Spoil Operations: Charles K. Rawls of the Chesapeake Biological Laboratory of the Center for Environmental and Estuarine Studies, University of Maryland, used NASA imagery, according to Sipple, in a study to survey the borrow pits in the Chesapeake Bay and to make recommendations for a treatment plant to handle spoil from dredging operations. Rawl's study was to include a review of literature about the subject. Rawls headed a task force which included Sipple and Dr. Eugene Cronin of the Center.

Delaware Wetlands Study: Sipple told of NASA data being used for mapping coastal vegetation during a charting of Delaware's coastal marshes by the College of Marine Studies of the University of Delaware. Imagery was retrieved by an RB-57 aircraft in 1970. The names of the investigators were V. Klemas, F. C. Diaber, D. S. Bartlett, O. S. Crichton and A. O. Fornes.

Future Uses of Imagery: Sipple said that the WRA might use NASA imagery in the future for updating the maps of the wetlands high-tide lines. Other future use might occur in a contract with a private firm for typing the vegetation throughout the state. In carrying out the contract, the private firm might make use of the NASA data already available.

Extending his thoughts about future uses of NASA imagery, Sipple spoke of the evidence that is accruing that the level of the ocean is rising. NASA imagery might be valuable in recording secular changes of the shorelines.

The WRA might rely exclusively on NASA data if the Department had the personnel to analyze the data and to prepare maps. Since this is not so, the Department will probably continue to contract with private firms. Very likely, private firms use NASA imagery as a matter of course. Sipple said that the WRA had contracted to have natural color photos taken of 13 Maryland counties and Baltimore City with Photo Science, Inc., of Gaithersburg, Md., and Raytheon Company, Autometric Operations, of Wayland, Mass., for \$200,000.

GPS cont'd.

At the conclusion of the interview, Sipple gave Harman a tabular record of wetlands cases in Maryland during the fiscal year, 1974. He also presented Dr. Harman a bibliography of literature about Maryland's tidal wetlands, published December 16, 1974.

STATE AGENCIES cont'd.

Maryland Geological Survey (MGS), Maryland Department of Natural Resources--Turbit H. (Chris) Slaughter, Randall Kerhin and Jonathan Edwards.

The function of the Maryland Geological Survey (MGS) is to supervise topographic, geologic, hydrographic and geophysical surveys conducted within the state. The MGS prepares topographic, geologic and such other maps as may be necessary to meet specific needs. It reports on the extent and character of the state's geology, mineral and water resources. In cooperation with the United States Geological Survey, it makes surveys of the water resources in the state. It also cooperates with the Federal Survey in certain geological and geophysical mapping projects. The MGS carries out research and investigations of coastal and estuarine problems relating to erosion and sedimentation along bay and ocean shorelines. The MGS's regulatory functions extend to the gas, coal and other extractive industries.

The Maryland Geological Survey began using NASA's imagery in 1972 when it signed a cooperative research contract with the space agency to conduct investigations with imagery acquired by the Earth Resources Technology Satellite and other sensing platforms. The MGS program was an inventory and evaluation of the state's mineral, soil and water resources. During the course of the contract, Skylab and airplane flights from Ames and Wallops were utilized as supplementary sources of imagery. The contract ended in 1973. The MGS presented a preliminary report to NASA in 1974; the final report is now (January, 1975) being typed.

The Maryland Geological Survey has used NASA data in the following instances:

Maryland Wetlands Permits: The state legislature in 1970 enacted a Wetlands Act prohibiting the dredging and filling of all state wetlands, public and private, except by permit. Permits are issued by the Water Resources Administration, General Permits Section, Annapolis, but the Maryland Geological Survey participates in the review of each permit application. Randall Kerhin of the MGS examines the situation surrounding each permit from a geological standpoint. The MGS makes its recommendations, favorable or unfavorable, by on-site inspection or by the examination of NASA imagery.

The number of permits to be reviewed is formidable--a thousand or more a year. With a small staff, two or three persons, the MGS is unable to visit the site of each permit application. NASA imagery enables the MGS to keep pace with the applications. Under the old system, the MGS could not process the applications rapidly or accurately enough. NASA imagery has truly transformed the operations of MGS in regard to applications review. Kerhin examines the imagery for such features as sand-involvement, direction of sediment flow, etc. Kerhin says that sand "stands out" as a prominent white band on infrared imagery. In actual practice, the MGS seldom rejects an application outright, although it frequently recommends that applications be modified.

Groins and Jetties: Applications for permits frequently involve the construction of structures to forestall beach erosion. These structures, stone or concrete walls extending perpendicularly across the shoreline to the water, are called "groins," or in the case of longer structures, "jetties." Groins and jetties are built by shoreline owners and real estate developers to protect their beach front property.

Kerhin is beginning to believe that groins do as much harm as good. He

MGS cont'd.

feels that groins preserve the shoreline in one place at the expense of that in another place. To judge the value of groins, Kerhin has used NASA imagery to study the behavior of sand flow near groins. He examines the imagery to learn the pattern of shoreline flow and the types of sediment present. He has come to suspect that shoreline groins and jetties affect the accumulation of sediment in navigation channels located at considerable distances away.

Kerhin says, "I can confidently say that our information about groins came from Wallops. We couldn't get the information any other way, unless we traveled there ourselves. And we just couldn't do that."

Ocean City Court Case: Under the Maryland wetlands laws, the state has the responsibility to protect the ocean and Bay shores and the property of landowners. The Department of Natural Resources is charged with the responsibility for maintaining the stability of the shoreline. In carrying out this charge, the Department watches over sediment movement and shoreline development.

When developers began to erect hotels, condominiums, etc., on the Ocean City shore front, they built directly on and beyond the dunes. Although the construction conformed to the municipal regulations of Ocean City, it violated state laws. The result was that the state contended with the developers in a court case. The first case was succeeded by others. The developers won the cases, but the state is appealing the decisions. To obtain evidence for use in court, the state asked for, received and used NASA imagery taken by low-altitude aircraft.

MGS Surveillance of the Atlantic Coastline: Turbit Slaughter and Randall Kerhin have 4000 miles of shoreline to monitor. Theirs is an enormous task, and without imagery, they would be unable to carry out this responsibility effectively. The imagery enables them to observe the dynamic processes of

MGS cont'd.

the water and shoreline interaction. Slaughter and Kerhin are able to observe such features as bedforms in the Bay, bars and troughs. These observations can hold the key to what is going on in the environment. Slaughter and Kerhin look at sand transport and the physical characteristics of the water (wave period, height and refraction).

The MGS compares the new imagery with photographs that are decades old. The aerial photographs available to the MGS were taken as long ago as 1937; they are in black-and-white and Kerhin calls them "terrible." Without the NASA imagery, Slaughter and Kerhin (or their assistants) would have to be constantly on the move doing "site-specific" work.

Kerhin says: "I now have a better picture and broader understanding of the Bay. Imagery is providing a valuable baseline on a regional basis for a coastline that constantly changes."

Slaughter says: "The imagery isn't seasonal. We receive it over an extended period—on a year-round basis. The seasonal dynamics become apparent. Before, we didn't know these things."

Maryland Environmental Atlas: The Environmental Geology Division of the Maryland Geological Survey has embarked on the preparation of an Environmental Atlas of Maryland. John Glaser of the Environmental Geology Division was responsible for the first efforts of the project when he obtained NASA Wallops cooperation to acquire aerial imagery of the Piscataway and Mt. Vernon quadrangle sectors in Maryland's Prince Georges and Anne Arundel Counties. Since then, other flights have been flown to obtain similar data for sectors of Charles, Cecil and Harford Counties.

The Environmental Atlas will represent an up-to-date and comprehensive source of environmental data on every part of the state. The Atlas will contain detailed information on mineral, water and land resources, general construction

MGS cont'd.

conditions relating to soil types, terrain gradients and structures and septic tank constraints. The Atlas will also contain data related to other pertinent subjects, such as the occurrence of ground water and the depth of overburden atop subsurface resources.

The Atlas is expected to be especially important in an assessment of the mineral resources and the development of the extractive industries. Surface mines, which presently constitute a sensitive political issue involving significant ecological and monetary considerations, stand out boldly on NASA's infrared imagery.

The Maryland Environmental Atlas, which will probably be funded cooperatively with the U. S. Geological Survey, will have the broadest of audiences. Its importance cannot be overestimated. Land use planners and private developers will consult its pages as their primary reference. Management and political decisions will be implemented on the basis of the information the Atlas contains. Its socio-economic implications are infinite. Without the use of data obtained through remote sensing, the value of such an Atlas would be much less.

The Maryland Geological Survey sees the Atlas as an inclusive collection of geological data in a form suitable for quick and easy reference by scientists and laymen alike. Jonathan Edwards of the MGS says that the concept of an Environmental Atlas may have entered the minds of the personnel of the Maryland Geological Survey as they studied the NASA imagery while preparing the Piscataway and Mt. Vernon quadrangle charts. Certainly, the extant NASA imagery will be utilized extensively in the Atlas' preparation, and it is likely that the MGS will seek more-recent imagery from Wallops.

In tribute to NASA, Jonathan Edwards of the MGS states that, although the Environmental Atlas could be created without imagery, techniques and equipment, the project would necessitate much field work and the use of aerial

MGS cont'd.

photography of limited usefulness. The Atlas would not be in the same detail and would require more time and money to complete, according to Edwards.

Imagery Use in Surface Mining: NASA Wallops imagery was used by Jonathan Edwards in an inventory of sand and gravel pits along the Baltimore-Washington corridor. Edwards and MGS personnel have also used infrared imagery from Wallops for mapping surface coal mines in western Maryland as well as researching deep mine locations, recording data and establishing boundaries associated with the coal mining industry.

Spoil Disposal Sites in Bay: The state of Maryland has the responsibility of providing disposal sites in the Chesapeake Bay for spoilage materials. It must report to the U. S. Army Corps of Engineers. Bearing on the disposal of spoilage materials is recent pressure from shipping interests to maintain and deepen the channels of the Bay to accommodate the deeper-draught vessels now coming into use. Accordingly, Greene Associates, a private engineering firm, was commissioned by the General Services Administration of Maryland to survey a list of possible spoilage sites. Greene Associates was also instructed to study these sites as possible locations for major recreational use.

Hart and Miller Islands as Long-term Spoilage Site: Hart and Miller Islands lie along the western shore of the Chesapeake Bay near the mouth of Back River about a dozen miles east of Baltimore Harbor. Hart, the larger of the two islands, is about two miles long and one-half mile wide at the broadest point. Miller Island is about one mile long and somewhat narrower than Hart. The islands are virtually joined by a strand of land.

For decades the islands have been used as a disposal site for materials dredged from Baltimore Harbor. Their importance is so great that the state stands in fear that the islands may shrink or disappear as a consequence of natural evolution. For 50 years the state has been advocating the creation of

MGS cont'd.

a large, rectangular dike on the islands' eastern margins along the Chesapeake Bay.

The proposed dike, two miles in length, would serve as an impoundment to trap additional sand and sediment, increasing the size of the islands by 1100 acres and ensuring the perpetuation of the spoilage site. The dike offers a highly desirable alternative to the overboard disposal of spoil in the open Bay with the attendant threat to fisheries resources.

The dike has the strong support of Secretary James B. Coulter, Secretary of the Maryland Department of Natural Resources, and is further endorsed by the chiefs of such other state agencies as the Geological Survey, Fisheries Administration, Wildlife Administration, the Park Service, Water Resources Administration and the Environmental Service.

The dike has already received the approval of Maryland's General Assembly and awaits final confirmation from the U. S. Army Corps of Engineers. If the dike is constructed, the state promises to convert the islands into a public recreational area under the Maryland Park Service and to seek federal assistance for the project from the Bureau of Outdoor Recreation.

Continuing aerial surveillance of the islands has clearly demonstrated that erosion will ultimately cause them to disappear unless something is done to stabilize them. In the last eight years alone, Hart Island has lost ten acres and Miller Island, seven acres. According to experts, both islands will vanish in the next three to seven decades.

Despite legislative and official endorsement, the proposed dike has elicited a strong, adverse response from the local residents who have traditionally used the islands for summer picnics and duck hunting. United States Congressman Clarence D. Long, Maryland, District II, has joined forces with residents and environmentalists to oppose construction of the dike.

MGS cont'd.

Storm's Effects on Hart and Miller Islands: The great storm of December 1, 1974, struck the Eastern Seaboard and Hart and Miller Islands with 50 to 60 mph easterly winds and tides two to four feet above normal. The storm posed such a danger to the integrity of this outstanding dumping site that Secretary Coulter telephoned the MGS to learn whether NASA Wallops had any imagery recording the storm's effects on Hart and Miller Islands. The Chesapeake Bay Ecological Program Center complied with the request by flying a special mission over the islands and the western shore of Anne Arundel County.

Erosion of Potomac River Banks: Erosion of the banks along the Potomac River is of continuing concern to the Maryland Geological Survey. The heavy rains (six inches in 24 hours) accompanying Hurricane Agnes in 1973 were responsible for extensive bank erosion. The Potomac banks are composed of the soil type known as Lower Cretaceous clays. NASA imagery showed the large-scale erosion caused by Agnes. In a symposium at College Park, Maryland, on the Effects of Hurricane Agnes on the Chesapeake Bay, NASA imagery was exhibited as graphic evidence of the relation between excessive rainfall and river bank erosion.

Hydrologists and scientists from related disciplines are beginning to focus their attention on the rainfall-bank erosion syndrome. Two theories to account for river bank erosion have been proposed: (1) heavy rains raise the water table to such a point that water issuing through the bank face causes erosion, and (2) lapping waves cause the erosion.

Barry McMullan of the MGS is a proponent of the first theory. He has used NASA Wallops imagery to document soil slumping along the Chesapeake Bay. The infrared imagery showed the talus in the water vividly. The two theories must still be evaluated. It is too early to make deductions or to set policies.

MGS cont'd.

Linearity Pattern in Plant Growth: Imagery from NASA Wallops was responsible for an unexpected and totally new revelation. Randall Kerhin, who was inspecting imagery for various reasons over an extended period of time, gradually became aware of a pattern of linearity in the arrangement of high marsh vegetation on Bay islands and shorelines. Appearing as a series of parallel stripes and bars on the imagery, the conspicuous configuration was especially evident on Middle and Lower Hooper Islands, Smith Island, Janes Island and Bloodworth Island near Tangier Sound off Wicomico County.

Kerhin is convinced that this vegetative pattern is significant. He believes it to be worthy of basic research. He speculates that it may be evidence of the outflow of the Susquehanna River, present or ancient. Kerhin's opinion is that the vegetation occurs on a series of ridges and has important implications.

Plant Signature Index to Geology: Relating to original research, Jonathan Edwards spoke of an interesting phenomenon which was detected during the examination of remotely sensed imagery. Observers noted that a particular kind of vegetation invariably occurred between two geological formations. The vegetation had a distinctive signature on the imagery which proved to be a certain index to the existence of the geological formations wherever it appeared. Edwards feels that the use of vegetation signatures for the identification of geological features can be extrapolated for application elsewhere.

Imagery for Basic Research: Turbit Slaughter says that the MGS engaged in no research until about 1963. Before that, the Survey's work consisted of doing inspections and making recommendations on request. Remotely sensed imagery is now enabling MGS to carry on research. Slaughter expects the Survey to expand its research program.

He says: "We are just getting up steam in research. We are more aware

MGS cont'd.

of what can be done. There is a huge amount to be done and NASA imagery is vital to the development of our research activities."

Groundwater Study at Parkville: Slaughter and Kerhin believe that NASA imagery was probably used in a study of groundwater in the Parkville, Maryland, area. Ed Otton of the MGS was in charge of the study. The study was conducted in cooperation with the Groundwater Survey Office.

Kerhin expresses his disappointment that NASA imagery he has used has not been able to reveal details in shallow water. He would like to be able to observe such features as bars and troughs and shallow water vegetation. He wonders whether other sensing systems might be able to accomplish what he wants.

When asked whether NASA's imagery has contributed to the public health, Kerhin answered that it has, and he cited the imaging done by the Wallops Flight Center of septic tank fields and the occurrence of groundwater.

Kerhin states that NASA imagery will be indispensable in the future for monitoring the ecological effects of off-shore oil drilling along the Maryland coast.

The following are some incidental quotations of Kerhin, Edwards and Slaughter:

Kerhin: "The MGS would be doing a lot less if we didn't have NASA imagery. We'll be using NASA imagery in the future whenever the need arises."

Edwards: "NASA imagery has allowed the department to use much less time in its work."

Slaughter: "We are interested in the Atlantic coast and Wallops and ERTS (Landsat) have enabled us to monitor it."

STATE AGENCIES cont'd.

Maryland Forest Service (MFS), Maryland Department of
Natural Resources--Tunis Lyon, Deputy Director

Tunis Lyon is the Deputy Director of the Maryland Forest Service. He is in charge of private land forest management throughout the state. He is responsible for the monitoring and control of insect and disease damage to the state's forests. (The actual study of insect and disease damage is the responsibility of scientists of the University of Maryland.)

NASA Wallops Imagery for Mapping Variable Oak Leaf Caterpillar Infestation:

Mr. Lyon enlisted the cooperation of the Chesapeake Bay Ecological Program at NASA Wallops in the fall of 1973 for mapping forest damage caused by an outbreak of the variable oak leaf caterpillar on Catoctin Mountain in Maryland's Frederick County. Lyon was already acquainted with the techniques and capabilities of remote sensing because he had been a central figure in the 1970-72 Delmarva Pine Bark Beetle Study, a program conducted with the cooperation of NASA Wallops.

The variable oak leaf caterpillar attacks a wide variety of deciduous trees. It attacks all species of oaks, but its preference is white oak. It is a heavy defoliator, especially in the South. Some outbreaks have been extensive, covering millions of acres and extending for hundreds of miles. When the caterpillars erupt in epidemic proportions, tree mortality can be serious. Although the variable oak leaf caterpillar had previously appeared on a small scale (20 acres or so) in Southern Maryland and on the Eastern Shore, it had never been detected in Western Maryland. Its appearance on Catoctin Mountain in the summer of 1973 was cause for deep concern since 80 percent of Maryland's trees are oaks and the major timber-type of the state's forests is oak-hickory. Commercially, the oaks are Maryland's most valuable.

MFS cont'd.

tree, except perhaps for the pines.

Catoctin Mountain is a north-south ridge of about 1700-feet elevation. The caterpillar infestation extended for five miles from Gambrill State Park northward toward the community of Thurmont. Also on the Catoctin Mountain are the Catoctin National Park and Camp David, the Presidential retreat. The infested area included a portion of the watershed for the reservoir of the city of Frederick.

After verifying the reports of the caterpillar outbreak, Lyon decided that it was imperative to determine the extent of the damaged area. He contacted NASA Wallops to request a special flight to image insect damage on Catoctin Mountain. Wallops complied, but it was later discovered that the wrong area had been imaged.

Another flight was scheduled and flown, but by then autumn had arrived and the deciduous trees were already dropping their leaves, making it impossible to distinguish definitely which trees had suffered caterpillar defoliation and which had shed their leaves naturally.

Lyon says that the remote sensing program was only "partly successful." It gave some idea of the extent of the damage, but unfortunately not all of the area was imaged by the aerial flight. Color infrared and black-and-white infrared imagery were taken. Lyon says that the infested trees were very evident on the color infrared film but that the black-and-white film was less satisfactory. Wallops provided both films and slides of the infestation.

Because the imagery was taken so late in the season, its value was limited. By October, frost and other influences had nearly obliterated the features that Lyon had hoped to analyze. Still, many insect-defoliated trees were obvious on the imagery and Lyon's office was able to delineate the general boundaries of the outbreak. If two or more flights could have been flown at

MFS cont'd.

intervals earlier in the autumn, Lyon believes he would have been able to ascertain the direction of the insects' spread, an item of considerable interest to him.

The imagery was further utilized by the Maryland Forest Service to train the personnel of the Service in detection of the variable oak leaf caterpillar and to acquaint them with the techniques of remote sensing. The imagery was also studied by scientists of the University of Maryland and the United States Forest Service.

In commenting on the extent and monetary effect of the infestation on Catoctin Mountain, Lyon estimated that 5000-6000 acres had been defoliated by the time of his request for NASA imagery. The past history of the oak leaf caterpillar shows that ordinarily two or three consecutive years of infestation are required to kill a tree. Notwithstanding, in instances of heavy infestation, a tree may succumb in a single season. Lyon sets the timber value of the Catoctin Mountain forest at \$300-\$400 per acre. If every tree in the affected area had been damaged beyond salvage, the loss would have amounted to between \$1.5 million and \$2.4 million.

The ownership of the Catoctin Mountain Forest is divided between private individuals and the city of Frederick. All parties harvest their timber on a regular basis. This does not mean that all of the trees are marketable; many are of a scrubby nature, and are only valuable for water retention and as a wildlife habitat.

Lyon says that the infestation erupted on Catoctin Mountain because 70 percent of the trees grew atop the ridge where they were stressed by the poor, rocky soil to the point that they were susceptible to insect attack. Many of the trees, predominantly oaks, were large--up to 18 inches in diameter. Past their prime, these larger trees would have been highly prized by lumbermen,

MFS cont'd.

even though they lacked the vigor to withstand the inroads of insects in epidemic proportions.

Lyon explained that the eradication of infesting caterpillars was not feasible for a number of reasons. Moreover, the expense involved would have exceeded the value of the timber. The only recourse would have been to harvest the infested trees before further depredations occurred.

Fortunately, the caterpillar population declined over the winter. During the spring and summer of 1974, observers could discover no evidence of renewed infestation. In discussing the consequences if the infestation had continued on Catoctin Mountain, Lyon concedes that the habitat would have been altered. With less mast available and with the understory vegetation eliminated, the lives of deer, squirrels and other animals would have been critically disrupted.

When asked what his course of action would have been if he had not been able to secure the services of NASA Wallops, Lyon says that Maryland Forest Service personnel would have mapped the infested area from the ground. The results would have been satisfactory, but the operation would have been "very time-consuming. Anyway, by the time the results were in, the trees would have been dead." Lyon feels that conventional aerial photography would have been so expensive as to preclude its use.

Bureau of Mines, Maryland Geological Survey--Harvey Monty Nock

The utilization of the remote sensing services of the Chesapeake Bay Ecological Program Center by the Maryland Bureau of Mines occurred collaterally during the course of the ERTS-1 cooperative study by the Bureau and the NASA Goddard Space Flight Center.

The Maryland Bureau of Mines is a division of the Maryland Geological Survey. The National Aeronautics and Space Administration carried out cooperative studies with the Maryland Geological Survey as part of its program to develop remote sensing techniques via the Earth Resources Technology Satellite #1. Arthur T. Anderson of NASA Goddard was a principal investigator in the application of remote sensing methods to strip mining in Maryland and West Virginia. Anderson's project was a test study, not a full-scale study. The project obtained imagery and digital tape data of sample areas in the Georges Creek and Upper Potomac River coal basins, not far from Westernport, Maryland.

Delineating Strip Mine Boundaries: One phase of Anderson's project was concerned with the demonstration of the utility of analog and digital techniques in delineating the boundaries of strip mines. In support of imagery and data acquired by way of the Earth Resources Technology Satellite, verification was obtained by ground truth expeditions and by underflights by NASA Wallops aircraft.

Geological Mapping of Western Maryland: Satellite imagery and data proved fully capable for purposes of geological mapping, but less satisfactory for delineating the boundaries of the strip mines (probably because many of the strip mines were too small to appear prominently from satellite altitudes).

The low-level imagery came to be highly valued by the Bureau of Mines personnel. In fact, they greatly prefer it to the satellite imagery.

Harvey Monty Nock fills the position of Geologist for the Bureau of Mines office at Westernport. He spends most of his working time in creating geological maps of western Maryland. The highest priority of his mapping work is given to the production of the 7.5 minute quadrangle maps of areas containing coal seams. These geological maps will become part of the projected Environmental Atlas of Maryland.

Nock believes that the long-term future of the coal industry is bound to the deep mines--not to strip mines. His reason for this belief is that coal reserves recoverable by stripping methods are limited. Nock says that the nation's largest coal operators have publicly stated that they do not plan to direct the major portion of their financial resources to stripping. These operators are cognizant of what the long-term trend in the coal industry will be.

Nock expects strip mining activity to increase for the immediate future. He says, however, that strip mining is contingent upon the price of coal, and that when prices decline, strip mining activity will decrease.

Presently, coal is bringing between \$20 and \$40 per ton. Low-grade coal (steam coal) used to generate electricity brings the lowest prices. High-heat coal (metallurgical coal) used to produce steel brings the highest prices.

General data about the coal industry in Maryland:

Latest production figures are for the calendar year 1974, when 2,050,000 tons were excavated through strip mining methods. Strip mine coal represented 93 percent of total production that year. The strip mining industry employed 389 men.

The law requires each coal operator to submit a detailed mining and reclamation plan. The revegetation bond is separate from the backfilling bond and varies from a minimum of \$50 an acre.

Bur. of Mines, MGS cont'd.

Total acres stripped in 1974: 700.3

Total acres planted in 1974: 513.0

Total acres backfilled in 1974: 566.8

Nock says, "No, the Maryland Bureau of Mines doesn't know how many strip mines exist in the two counties. (*Interviewer's note: All Maryland coal is produced in two counties--Allegany and Garrett. The counties are treated as a single entity in this interview.) Records were never kept until reclamation legislation was enacted in the middle 1960's. I don't know why. No, we don't know the acreage involved either.

"Our records show that 256 surface mining permits have been issued since 1966. Before that, I don't want to attempt an estimate. (The interviewer interrupted Nock to ask whether 1000 would be a logical estimate, but Nock neither affirmed nor denied the estimate.) Strip mining is on the increase, mainly because of the higher prices available. And it will grow greater.

"In the calendar year, 1972, we issued 14 strip mining permits. In the calendar year, 1973, 37 were issued. Our records haven't yet been compiled for 1974, but there was a dramatic increase. In 1975 the number has been greater than ever.

Inventory of the Strip-mine Disturbed Ground: "With the color infrared imagery from low altitude that NASA can provide, for the first time the Maryland Bureau of Mines will know the extent of the strip-mine disturbed ground.

"We'll also know how much land we'll have to reclaim. We'll know how much money will be needed for reclamation. We'll know also whether the old strip mines are revegetating themselves. We're confident that today we can establish vegetation on the disturbed mines and restore the land to a

condition better than before."

Locating Old Deep Mines: Nock says that although the Bureau of Mines' usage of NASA remote sensing has thus far been confined to the investigation of strip mining, the Bureau is optimistic about remote sensing's application to deep mining. The Bureau does not have records of the number or location of former deep mines. Nock feels that techniques could be developed rather easily to detect water drainage from old mines.

In presenting the background of this type of investigation, Nock explains that the sites of old mines are not known, since the mines operated before records were kept. Because of the rugged terrain involved, terrestrial searches are most difficult. (The surface openings of deep mines often are quite small and the vegetative growth of subsequent decades has effectively concealed them.) Terrestrial searches could not be carried out anyway, because the Bureau has neither the personnel nor the funds to support such activities.

The identification of old, unknown deep mines is founded on the fact that water drains to the surface either continuously or intermittently from the depths of the mines, and that this water can be readily detected by remote sensing methods. By comparing the imagery with conventional maps showing the area's drainage network, the sites of old deep mines can be determined.

Nock feels that thermal remote sensing could be effective in locating old deep mines. He reasons that the temperature differential between surface water courses and mine drainage would provide the clue. Nock favors nocturnal remote sensing for this type of investigation.

Acid drainage is another kind of environmental pollution that accompanies the coal mining industry. Ground water percolating through the coal seams leaches out sulfur and creates sulfuric acid. If this water eventually reaches

Bur. of Mines, MGS cont'd.

the surface again, and it is common for it to do so, it has a lethal effect on the animal and fish life of the streams and rivers. Many of the waterways in the heart of the Appalachian coal fields are now biologically sterile.

(Hundreds of fishermen acting individually or through organizations of anglers wage vigorous campaigns to halt acid drainage.)

Certain mountain streams in western Maryland have been victims more than once of sudden infusions of mine acid. Usually the infusions have occurred after heavy rains. The effects on the fish population have been catastrophic. Bear Creek, a notably pure and attractive stream in Garrett County, feeds the State Fish Hatchery. When this stream fell victim to an incursion of mine acid, every fish in the Hatchery, including hundreds of brook trout of various ages, was killed within a day's time.

Acid mine drainage can be prevented. Several remedial methods are practicable. The eradication of mine acid pollution is obviously dependent on the success of authorities in locating the site of every abandoned deep mine.

Monitoring Compliance with Mining Permits: "Yes, we could use the imagery as a tool for enforcement. With a planimeter, we could measure the area of an operating strip mine. We could go to the operator and say, 'You've exceeded the bounds of your permit' or 'You're not revegetating the disturbed land to the degree that your permit requires.' The imagery would be regarded by the Bureau as incontestable proof of violations. However, to my knowledge, we haven't yet used the imagery in this way."

Nock says: "The satellite imagery is fine for delineating the areas disturbed by strip mining, but it isn't much use for any other of our purposes. Imagery taken by aircraft at altitudes of 20,000 feet and 10,000 feet tells us what we want to know.

Bur. of Mines, MGS cont'd.

"Lower-altitude imagery, even from very low altitudes, can tell us three things we need to know about the strip mines: (1) the delineation of the disturbed ground, (2) the delineation of the areas which have been backfilled, and (3) the delineation of the areas which have been backfilled and are sustaining vegetation.

"Multi-spectral imagery has yielded us some interesting material--and it may be of great value to investigators in other disciplines--but color infrared imagery allows us best to see and study the elements of the earth's surface we are most concerned with. Here! take a look at these different types of imagery. I can point out the features that provide us the data we never had before."

Imagery's greatest value to the Bureau of Mines would lie in its repetition. Old, new and evolutionary aspects of any subject are of the greatest importance.

Nock says that aerial imagery obtained on a periodic basis would enable the Bureau to continuously monitor strip mining activity. Even if the imagery were available only annually, it would be of the greatest merit.

The Bureau has three inspectors whose multiple duties keep them so busy that they can scarcely carry out all their responsibilities. One of the duties of the inspectors is to visit each strip mine site and physically measure (by tape) the extent of disturbed areas, backfilled areas and revegetated areas. With the number of new strip mines increasing ever more rapidly, the inspectors are almost overwhelmed.

Monitoring by remote sensing would be quicker and more accurate than by on-site inspections.

Nock's list of NASA imagery on file at the Bureau of Mines' Westernport office:

Bur. of Mines, MGS cont'd.

1. U-2 imagery (1972)
2. Infrared imagery from 20,000 feet (1973)
3. Infrared imagery from 20,000 feet (1973)
4. ERTS-1 imagery "which is good for mapping"
5. Color infrared imagery from 3500 feet--"my preference for monitoring" (1973)

Asked by the interviewer what his office would do if NASA imagery had not been available, Nock could not find an answer. In essence he was saying, "Nothing, we just wouldn't get the job done. I guess we would try to obtain grants, from whom I don't know."

Nock and the Bureau of Mines are planning to request imagery from NASA (Wallops or Goddard or both) in the near future.

Nock: "No, I don't think private companies engaged in remote sensing can do as good a job as NASA. They don't have the equipment--the sophisticated, highly developed equipment--that NASA does."

A deterrent to Nock's use of NASA imagery is his belief that the cost would be too great. He is not certain of the procedure for ordering imagery from Sioux Falls. He doesn't know whether he should order the imagery through Wallops or Goddard.

Nock says that the "red tape" and number of forms required when requesting the services of NASA is formidable. This is also a deterrent to his use of NASA's services.

STATE AGENCIES cont'd.

Maryland Department of Chesapeake Bay Affairs—John R. Capper,
Deputy Director

John R. Capper was formerly the Deputy Director of the Maryland Department of Chesapeake Bay Affairs. The Department, formed in 1964 and disbanded in 1972, was a management agency invested with authority over the commercial and sport fisheries of Maryland's tidewater region. The Department's function was to promote and regulate commercial and recreational activity in the waters and along the shores of the Chesapeake Bay and Atlantic Ocean. Commercial and recreational boating also came within the Department's purview. One of the Department's foremost duties was to formulate policy.

The Department of Chesapeake Bay Affairs engaged in a variety of programs, including shore protection and erosion prevention and oyster bed repletion. The Department regulated dredging and filling operations in the tidewater region and monitored all other physical modifications.

Capper became interested in remote sensing at the time the Department began to map the tidewater region in response to the State Legislature's mandate to delineate all Maryland wetlands. Capper felt that remote sensing could be applied to various phases of the Department's activity: pollution detection and surveys; identification of littoral changes; assessment of storm effects.

When NASA Wallops sponsored a conference in conjunction with the announcement of its remote sensing program, Capper attended. The purpose of the conference was to introduce representatives of public agencies and academic institutions to remote sensing technology and concepts and to interest the delegates in utilizing remote sensing in their work.

Md. DCBA cont'd.

Capper said: "At the Wallops conference, there were a lot of science 'types,' and then there were guys from agencies--like myself. A reporter from the Baltimore Sun asked me to explain the gist of the new NASA program, and I told him I couldn't. I told him that I felt like the character in Kafka's Castle. My quotation was printed in an article in the morning edition."

* Capper's analogy referred to the protagonist in an unfinished novel (1921-26) by Franz Kafka. The novel, Das Schloss, portrays a man standing before a grand but forbidding castle which he is bound to enter yet can discover no access. Although frustrated and baffled, he cannot leave, for the castle has bewitched him. Scholars regard the story as an allegory depicting the wretched situation of the common man in confrontation with a bureaucratic world.

In discussing the Wallops conference with the interviewer, Capper indicated that although "there was a lot of talking between the NASA personnel and the potential users," little concrete information was imparted which would have enabled the uninitiated to make immediate and direct use of remote sensing in their work.

Mapping the Tidewater Region and Obtaining Basic Data for Planning Decisions: Capper told the interviewer that at the time of its association with NASA Wallops, the primary needs of the Department of Chesapeake Bay Affairs were (1) for a system for mapping the tidewater region and (2) for basic data on which to make planning decisions.

Capper said that his attempts to develop a working relationship with Wallops failed. Thus, the Department of Chesapeake Bay Affairs never utilized the remote sensing services of NASA Wallops, except in very slight degree.

Md. DCBA cont'd.

The records of NASA Wallops seem to contradict this portion of Mr. Capper's testimony. According to a transmittal slip dated July 13, 1971, color infrared duplicate color transparencies and three rolls of film, a total of 274 frames, were sent to the Department of Chesapeake Bay Affairs for "ecological studies of Maryland's wetlands."

It is Capper's opinion that his experience and educational training were ill-suited for enabling him to recognize the applicability of remote sensing to the needs of his Department.

Capper said: "I thought in terms which were too simplistic. What I wanted at that time was just a good, synoptic picture of an entire region--a view from long range--one that could be used for briefing my staff--a view that would show the different aspects of the shoreline, and so forth."

Capper feels that his inability to integrate himself and his work with the NASA operation may have owed to the very nature of the NASA organization. He sensed a lack of communication among the various divisions of NASA Wallops, and also among the various NASA flight centers around the country. As evidence, Capper cited the fact that whereas NASA Houston had made a major overflight of a geographical region in which Capper was interested, NASA Wallops was unaware of the flight or of the derived imagery.

Capper said: "Originally, I thought that ideas for utilizing remote sensing in my work would pop right out. But they didn't."

"Our Department wanted to do prototype work--to discover what altitudes were best--to learn what types of imagery were suited. But I found that accessibility to NASA was limited. We obtained a roll of high-altitude film from Houston which we found very useful, but we needed lower-altitude film also. We received only a small quantity of imagery from Wallops. Flights by Wallops were planned, but they were never flown. I don't know why. Maybe it was because

Md. DCBA cont'd.

Wallops couldn't secure the special equipment that might have been required.

"I was never able to put something together with Wallops. Either what I wanted was too specific or it was too general. I don't know which. The Department of Chesapeake Bay Affairs wound up spending \$300,000 with commercial firms for producing wetlands maps of the Bay."

The commercial mapping was done by airplane from an altitude of 6000 feet. As best as Capper could recall, the altitude provided a scale of 1:12,000. The majority of the photography was done by kodachrome film, but some was also done by color infrared film. One phase of the work was devoted to the mapping of tidelands vegetation. Charting of the high-tide margin was accomplished by black-and-white infrared film.

The commercial work was performed for the Department in 1970-71 by two firms: (1) Photo Science, Inc., Gaithersburg, Maryland, with the participation of consulting biologist, Art Anderson, The American University; and (2) Raytheon Company, Wayland, Mass. (Sub-contractor: Keystone Company, Philadelphia, with the participation of consulting biologist, Jack McCormick). *Capper commented that the work of Keystone and McCormick was "very good."

Capper said: "In the Department's association with NASA, our intention was only to do pioneering work. We wanted to learn what equipment and methods could be used in our operations. We were just a bunch of amateurs. Unfortunately, we weren't able to explain to the people at NASA what our purpose was. Other users were interested in scientific accuracy and cartographic precision, but we weren't. It was hard to get people to understand this.

"In fact, when we interviewed the various commercial firms about doing the Department's contract work, they didn't understand us either. Some of the firms were reluctant to take on the work because it wasn't rigorous enough. Because of this, they presented bids which were excessively high--running into the

Md. DCBA cont'd.

millions of dollars. I guess they thought their professional reputations would suffer if it became known they'd done our kind of work.

"It's difficult for a state agency like the Department of Chesapeake Bay Affairs--with many functions and not much time--to work with a large, amorphous, federal agency like NASA. At least that was true under the arrangement that existed then. Perhaps it's different now. I don't know.

"What was needed was a better appreciation by the NASA people that state staffs aren't equipped for working with an outfit like NASA. Maybe NASA should create a liaison group to bridge the communication gap that lies between us and their technology and bureaucracy.

"As I said before, the Department never could get much going with NASA. Much of the fault was theirs, but I guess some of it was ours too. There is some sort of organizational flaw in the structure of NASA."

John Capper left the employ of the State of Maryland in 1972, the same year that the Department of Chesapeake Bay Affairs disbanded. He has since returned to state employment and is presently an official in the Land Planning Services division of the Maryland Department of Natural Resources. He has offices in the Tawes State Office Building in Annapolis.

In his present work, Capper continues to prefer aerial photography to conventional maps. Exactness and nicety are not important considerations. His primary need is for photographs unencumbered with details but offering broad overviews to permit rapid assessment of situations and conditions.

Capper hopes to compile a library of aerial photography of the entire state at his own office. Instant accessibility of the photography is of paramount importance, and Capper is not disposed to consult film libraries located elsewhere. He expects to acquire a light-table and other equipment which will enable him to carry out his duties without leaving his office.

STATE AGENCIES cont'd.

Virginia Division of Forestry, Insect and Disease Investigations--
Caleb L. Morris, Chief

Caleb L. Morris is the Chief of Insect and Disease Investigations for the Virginia Division of Forestry. He was trained as a forest entomologist and tree pathologist. He holds a Master's Degree and studied at Yale and Syracuse Universities. His office and laboratory are located on the campus of the University of Virginia at Charlottesville.

Delmarva Bark Beetle Campaign: Morris was deeply involved in the campaign against the southern pine bark beetle epidemic on the Delmarva peninsula in 1971-72. Morris calls the campaign "a success," representing the first concerted control program by a broad coalition of timber companies, wood processing industries, state and federal forestry agencies, private woodlot owners, public officials, extension agents and land use planners.

The Virginia Division of Forestry spotted the beginnings of the pine bark beetle outbreak in the loblolly pine forests of the eastern shore counties of Accomack and Northampton in the course of an incidental aerial survey by its own personnel in early September, 1970. To better appraise the situation, the Division hired additional photographic flights.

The critical importance of the pine bark beetle's threat to Delmarva forests is certified by the fact that the United States Forest Service financed one-third (\$1,080) of the cost of the survey flights, landowner contacts and marking activities.

The boreholes created in the tree by the beetle often do less to degrade the quality of the timber than the fungus which the insect introduces. The fungus rots the sapwood, severely affecting the strength of the wood. Moreover, the fungus suffuses a blue stain which further decreases the desirability of

VDF cont'd.

the timber. Bleaching is effective for removing the stain if the stain is not too vivid.

The control program on Delmarva was essentially "a salvage operation," requiring the immediate harvesting of the affected stands. The epidemic subsided naturally during the late summer of 1971. Morris describes the epidemic as "collapsing under its own weight." Salvage operations were never carried out to the intended degree because of a glutted market and the lack of storage facilities.

Outbreaks of the southern pine bark beetle do not occur uniformly throughout the affected forests. Rather, they occur in discrete, localized areas, normally less than 50-75 acres in size.

The bark beetle epidemic of 1970-1971 and the work record of the Delmarva Bark Beetle Council, according to Morris, have so impressed the private woodlot owners of Delmarva that there now exists a general acceptance of state policies and a willingness to comply with recommendations for immediate salvage of affected stands. Morris says that the participation of industry was crucial to the success of the Council's program.

The extent of the Delmarva beetle epidemic is indicated in a publication by Morris:

"...estimates of dead and dying timber in that one Virginia county (Accomack) totaled 15 million board feet. In Maryland (5 counties) estimates of dead and dying timber were placed at 35 million board feet and in Delaware (one county) 5.6 million board feet. Later estimates in 1971 by Baliko when the epidemic had run its course placed the total damage on DELMARVA at between 75-100 million board feet."

VDF cont'd.

The scope and seriousness of the pine bark beetle is evidenced by the fact that the United States Congress has appropriated \$20,000,000 for study of the beetle. The appropriation extends for the five-year period, 1974-78. Most of the research involved will be conducted by universities.

Frontalure-Cacodylic Acid Experiments in Prince Edward State Forest:

In conjunction with the Delmarva campaign against the pine bark beetle, experiments were conducted with Frontalure, a beetle attractant. Caleb Morris directed the experiments. Frontalure was used to concentrate the beetle population, rendering it more amenable to control measures. The term "Frontalure" derives from the pine bark beetle's scientific name, Dendroctonus frontalis Zimmerman. The chemical's volatility is important to its use as an attractant. Baiting a tree requires 3 cc. of Frontalure. The cost is about \$3 per tree. Morris says that his studies have shown Frontalure to be responsible for a 60-70 percent reduction in breeding (failure of the young to emerge).

Morris enumerated the contributions, direct and indirect, of NASA Wallops to the bark beetle campaign on Delmarva:

- (1) NASA Wallops provided a 130-acre woodland area in which the Virginia Division of Forestry conducted a test of the effectiveness of Frontalure. NASA also contributed financially to the purchase of the chemical.
- (2) NASA Wallops flew one complete aerial photographic survey and one partial survey of the epidemic area.
- (3) Photographic interpretation facilities at Wallops were made available to the investigators.
- (4) Contact prints of the infrared survey photography were made available by NASA Wallops to state foresters concerned with spot

VDF cont'd.

location and landowner contact.

(5) NASA Wallops cooperated with the Virginia Division of Forestry to conduct a series of evaluations of the use of infrared film and various filters to increase the effectiveness of aerial photographic methods to detect beetle infestations.

(6) NASA Wallops assisted in an assessment of an optical-mechanical infrared heat scanner for detecting beetle infestation.

In late 1971 and early 1972, NASA Wallops assisted the Virginia Division of Forestry with two photographic surveys of the Prince Edward State Forest, Prince Edward County, in a continuation of the Frontalure--cacodylic acid control tests.

Pine Bark Beetle Control Program in Cumberland State Forest: NASA Wallops flew an aerial photographic survey of the 15,000-acre Cumberland State Forest in 1972 at the request of the Virginia Division of Forestry. Five hundred and sixteen pine bark beetle-infested localities were identified on color infrared film. Because of the findings, the state foresters recommended that the larger localities be salvaged at once.

The smaller localities became the scene of experiments using the chemicals Frontalure and cacodylic acid. Frontalure was used to attract and concentrate the beetles. Cacodylic acid, an arsenate compound, was applied to an incised strip girdling the base of the trunk of each baited tree. The acid was also applied to several non-baited trees in the near vicinity of each baited tree. Cacodylic acid, a poison, was tested for its effectiveness in suppressing the beetle population through the inhibition of breeding. The experimenters concluded that cacodylic acid was effective if administered in

VDF cont'd.

accordance with other factors affecting the beetle's breeding schedule.

The campaign against the pine bark beetle in the Cumberland State Forest differed from the campaign on Delmarva because the Cumberland State Forest lies in the Piedmont District of Virginia where short-needle pine species like the Virginia pine predominate.

In illustrating the economic significance of the pine bark beetle's depredations, Morris reports that \$2,000,000 worth of pine timber had to be salvaged in Virginia in 1974, mainly because of pine bark beetle infestation. The figure would have been greater, except that a large percentage of the trees had been degraded to the point that they were unmarketable.

Because of infestation by insects, mainly pine bark beetles, 28 percent of the potential saw timber of Lunenburg County in extreme southern Virginia was destroyed in 1974-75. Moreover, 12 percent of the pulp timber was lost.

Morris says that the ravages of the pine bark beetle are continuing outside Virginia. He describes a current outbreak in other southeastern states.

The United States Forest Service is now engaged in surveillance via remote sensing, and Caleb Morris has been asked to make recommendations about the operation.

Morris was "extremely pleased" with the assistance that NASA Wallops provided the Virginia Division of Forestry in the investigation of beetle infestation in Prince Edward and Cumberland Counties. Morris says that NASA's support was responsible for a "valuable and complete" study in the Piedmont District which could not have been carried out otherwise.

In discussing the relations between the users of the remote sensing services of NASA Wallops and the NASA personnel, Morris says that many of the people at NASA are "theoretical people and sometimes we don't understand

VDF cont'd.

one another very well. We get things done, however, because each party takes charge of the phase of the operation it knows best."

"We used the thermal scanner on the pine bark beetle project. The Virginia Institute of Marine Science and the Smithsonian Institution were in on the project too. The University of Michigan sent down an airplane for the project. Things didn't work out because the temperature differential wasn't sufficient. The season of the year must have been wrong for the work."

"I can make nothing but complimentary comments about the service and cooperation of the Wallops Ecology Program."

"I don't know the present state of the Delmarva Council. I haven't had time to follow up previous work and contacts. I put it all under the category of 'unfinished business.' I hope to catch up on things this winter."

"What you might call a 'shortcoming of Wallops' remote sensing services is the unavailability to users of original photographs. Copies are provided, but the copies oftentimes don't yield enough details. Sometimes I'd like to be able to take the original into the field."

"The Frontalure experiments were in the category of 'original research.' It was the first time that an attractant had been used for control purposes."

"We are hopeful that our research on the pine bark beetle will enable us to construct predictive models for future insect attacks."

"NASA's imagery isn't getting the multiple usage it deserves. It's a shame that more people don't know about the availability of the remote sensing services."

STATE AGENCIES cont'd.

Virginia Institute of Marine Science, Remote Sensing Section--
Hayden H. Gordon and John C. Munday.

The Virginia Institute of Marine Science is an agency of the State of Virginia serving under the authority of the state legislature. The Institute is chartered to perform research and to make recommendations on matters pertaining to the state's tidal waters. The state's ocean waters (to the edge of the continental shelf 60 miles offshore) and salt marshes are considered to lie within the Institute's purview. The institute has carried on scientific studies from Delaware Bay to Cape Hatteras, a region corresponding to the "Virginia Sea" of colonial days.

The Institute also serves as an academic institution, maintaining a training program for graduate students from William and Mary College who are candidates for M.S. and Ph.D. degrees in marine science.

The activities of VIMS have always been linked closely with the state's marine industry, particularly with the commerce in shellfish and finfish. Until 1962, the Institute was known as the Virginia Fisheries Laboratory.

Although historically the marine industry has received the major share of the Institute's attention, today problems associated with environmental pollution and coastal zone management are being treated with equal importance.

Remote sensing operations at VIMS are conducted by a Remote Sensing Section loosely attached to the Department of Geological Oceanography. No effort is made to define the Section's precise position within the Institute's organizational structure, since the application of remote sensing crosses disciplinary boundaries.

Hayden H. Gordon and John C. Munday are employed at VIMS as Assistant Marine Scientist and Associate Marine Scientist, respectively. Both men

VIMS cont'd.

have worked at the Institute for a number of years. Like about half of the personnel at the Institute, Gordon and Munday receive their salaries through financing provided by grants.

John Munday worked in the Remote Sensing Section during the early period of the Institute's cooperative contract with NASA Wallops. He later left VIMS, returning in recent months to resume his work in the Remote Sensing Section. Hayden Gordon joined VIMS and the Remote Sensing Section during Munday's absence from the Institute.

The association between VIMS and NASA Wallops began when Wallops awarded a contract to the Institute for the purpose of researching the application of remote sensing to marine science. As recalled by Gordon and Munday, the contract was in the amount of \$30,000 to \$50,000. For the VIMS research projects, NASA Wallops made available the services of two C-54 aircraft, a Fairchild T-11 camera, a Hasselblad 500 EL camera and thermal scanners. The contract extended through 1974; a final report was submitted to NASA in early 1975.

Under the contract with NASA Wallops, VIMS performed research on four separate projects:

(1) Behavior of oil slicks on the Chesapeake Bay. The objective of this project was to develop methods of treating oil slicks caused by accidental spills in the state's estuarine and coastal waters. The results of the studies should be of paramount importance in light of proposed offshore oil drilling and transferral stations along the Atlantic Ocean.

VIMS' investigations concentrated on the form, thickness and spread of slicks, the evaporation rates of the various volatile constituents of the oil, and the testing of different film/filter combinations for imaging the slicks.

VIMS cont'd.

The Environmental Protection Agency participated in the project by funding a VIMS chemist to assist in the studies. The Naval Research Laboratory also participated in the project, through the work of James Hollinger who used the NASA radiometer for nighttime and all-weather monitoring of the Chesapeake Bay.

What was learned through the project will be valuable to the United States Coast Guard, the agency charged with responsibility for surveillance of the Bay conditions.

(2) The aquatic environment at the Virginia Electric Power Company's new nuclear plant at Hog Point on the James River. This project was carried on in conjunction with a VIMS contract with the Atomic Energy Commission to record conditions in the James River before, during and after construction of the nuclear plant.

VIMS used NASA's infrared scanners to record the size and configuration of the plant's aquatic thermal plume, to observe changes in the plume produced by wind and tide, and to do isothermic mapping. Supportive data were obtained through transects done by VIMS boats.

According to Hayden Gordon, the value of the infrared scanners to the project was reduced by the distortion inherent in the instrument. Gordon says that the scanners malfunctioned so often that they could not be considered successful.

(3) Dynamics and evolution of the Virginia barrier islands. This project was coordinated with ongoing studies of the Virginia barrier islands which VIMS has been conducting for many years and at an accelerated pace for the last five years. The islands and the surrounding waters were imaged by black-and-white infrared photography.

The project looked closely at inlet dynamics, a field in which the

VIMS cont'd.

Department of Naval Research was then carrying on parallel studies. The project also examined littoral changes and the alteration of navigable inlets caused by storms.

The project was successfully carried through and information from the studies has since appeared in various publications.

The project produced a bonus for the investigators by pointing out the importance of two little-studied aspects of coastal processes: (1) the volume storage function of inlets and (2) the flushing capabilities of the contained waters. The Institute is presently engaged in further research on the subjects.

(4) Applicability of remote sensing to marsh studies. In accordance with the announced intention of Virginia authorities to inventory the state's wetlands, the Institute addressed itself to determining which instruments and techniques of remote sensing were best suited to the inventory. Michael Penny of the VIMS' Remote Sensing Section explored such factors as sun/view angles and photographic densities.

As a direct result of the preliminary work carried out during the cooperative NASA project, the state subsequently awarded VIMS the contract to conduct the inventory. Work is now in progress.

Quoting Hayden Gordon and John Munday--

H. Gordon: "I'm not sure that here at VIMS we could ever get enough money to hire commercial firms to do our remote sensing work. We might, though. If we could go to the state and prove to them that remote sensing would be cost-efficient for a particular project, we just might get the funding."

H. Gordon: "I think that maybe ERTS (Landsat) could do the job of inventorying the wetlands."

VIMS cont'd.

H. Gordon: "It seems possible that certain governmental agencies might get involved with commercial remote sensing. For instance, I can conceive of the Coast Guard buying remote sensing packages from private firms, then installing the packages on their own planes. I don't believe they would hire the firms to do the work."

H. Gordon: "NASA Wallops needs a reliable infrared scanner. We wanted a scan at least once a month, but what we got was only three scans all told. The scanner just didn't achieve what was hoped for."

J. Munday: "I just returned from working in Canada. Up there, the government is beginning to charge the remote sensing users for things which were free in the past. More and more the Canadian users are having to pay for remote sensing services. I guess maybe NASA might be forced to adopt the same policy."

J. Munday: "I'm afraid that if NASA abandons their remote sensing programs at this time, under the assumption that the research and development phase has been completed, the university students of today and of the future will never receive training in remote sensing."

"As evidence, I recently encountered a graduate student working on a project here at the Institute who was using a tedious, old-fashioned method to obtain data on a study that was suited perfectly to remote sensing. When I asked him why he wasn't using remote sensing, I discovered that he had never had any training in the field, and, in fact, was not used to thinking in terms of remote sensing--even in its simplest forms."

"This incident proves to me that remote sensing has not yet found its place in the academic institutions. It means that additional time is needed for remote sensing to become established as a discipline in the schools. I'm worried that remote sensing might wither and die unless NASA supports its programs for at least a while longer."

UNIVERSITY AND COLLEGE

Pennsylvania State University, Space Science and Engineering Laboratory--George McMurtry, Co-Director.

In 1965, Pennsylvania State University signed a contract with the National Aeronautics and Space Administration whereby the University would be supported financially in the application of space science and technology to the investigation of the earth environment. To act as signatory to the contract, the University created the Space Science and Engineering Laboratory, a research organization whose structure transcends college and departmental boundaries. The Laboratory is headed by the Assistant Dean of Engineering Research.

The PSU-NASA contract was for the five-year period 1965-1970. The University regarded the NASA financial contributions as "seed funds" provided for the purpose of stimulating a variety of scientific investigations into disparate aspects of man's environment. Because the Space Science and Engineering Laboratory is only a nominal organization, the University established the Office of Remote Sensing of Earth Resources to serve as the ultimate beneficiary of the NASA funding and to conduct the actual program of investigations.

The Office for Remote Sensing of Earth Resources is comprised of ten faculty members from various colleges, departments and disciplines of the University. The realms of agriculture, architecture and engineering, among others, are represented. George McMurtry, an electrical engineer, and Gary Peterson, an agronomist, were appointed Co-Directors of ORSER.

ORSER occupies three or more large rooms in the Electrical Engineering Building West. The quarters include an office, a laboratory, and a data

PSU cont'd.

storage and retrieval system housed in the same or an adjacent building. In addition to the Co-Directors, an office secretary and an image analyst are permanent employees. A computer programmer is hired on an intermittent basis.

The Office of Remote Sensing of Earth Resources was initiated in 1969 with Gary Peterson as the single Director. Operations moved slowly at first, and, in 1970, Peterson called in McMurtry to invigorate the program and to serve as Co-Director.

McMurtry was invited to join ORSER because of his special background. As an electrical engineer, he had considerable experience in pattern-recognition. His interpretation of the visual patterns of sonar and speech involved analysis of multi-spectral data. His interest in remote sensing was evoked by his work with multi-spectral data.

Although the PSU-NASA contract formally expired in 1970, some unexpended funds remained. NASA has since granted an extension of the cooperative arrangement so that McMurtry can utilize the remaining money for the analysis of data and the preparation of reports.

Under the NASA contract, the remote sensing investigations of the University concentrated on a diversified program of studies on Pennsylvania's Susquehanna River Basin. One of the major rivers of the United States, the Susquehanna is a major tributary of the Chesapeake Bay. The Susquehanna Basin is the site of intensive commercial and residential development. Harrisburg, the state capital, lies on the Susquehanna's banks.

The remote sensing studies program of the Susquehanna Basin was conducted by authorities in many disciplines and involved the following subjects:

- (1) Inventory and mapping of geological lineaments (surface manifestations of sub-surface faulting which in the Susquehanna Basin extend transversely across the ridges)

PSU cont'd.

- (2) Inventory and mapping of coal strip mines
- (3) Inventory and mapping of spoil piles of coal deep mines
- (4) Mapping of land use (agricultural, residential, etc.)
- (5) Monitoring of gypsy moth infestation
- (6) Mapping of forest types and vegetative cover
- (7) Survey of air pollution effects on vegetation
- (8) Survey of the effects of industrial smoke on nearby vegetation
- (9) Observation of the effects of industrial thermal discharges on the river's plant life
- (10) Inventory of sink holes in karst regions
- (11) Location of the overgrown route of an historical canal

This program of studies involved underflights of C-54 aircraft from NASA Wallops and other aircraft from other NASA stations.

In the course of the program, the Office for Remote Sensing of Earth Resources developed a digital processing system as a valuable tool for the interpretation of data. Since completion of the Susquehanna Basin studies, ORSER has used NASA data to answer requests by other clients. The professors and students of the University's landscape architecture curriculum have frequently used the imagery and digital information. Planning officials from Clinton County (Pa.) visited the ORSER Laboratory to examine imagery and to extract data.

Pennsylvania State University is a member of the Marine Science Consortium, an organization of about 20 inland universities and colleges whose members use the Consortium's Center at Wallops Island for on-site instruction in the marine sciences. The Consortium is financially supported by the contributions of the member organizations. Consortium Center classes often visit the NASA

PSU cont'd.

Wallops Flight Center to study the remote sensing operations conducted there.

Pennsylvania State University sponsored a ten-weeks course for undergraduate students at the Consortium Center in Spring 1975. The course, under the direction of Albert Guber of the PSU geology faculty, was devoted to marine biology, marine geology and instrumentation. Fifty students, representing many different fields of study, attended.

Mr. Guber, who has long been keenly interested in PSU's remote sensing program, invited George McMurtry to come to the Consortium Center to teach an intensive two-days course in remote sensing. McMurtry, in turn, requested and received permission from authorities at NASA Wallops for his students to visit the Flight Center to observe the remote sensing operations of the Chesapeake Bay Ecological Program. Permission was granted and the students visited the Flight Center on March 27 and 28.

Each of the students was required to carry out an original scientific project while at the Consortium Center. At least eight to ten of the students secured remote sensing imagery from the Chesapeake Bay Ecological Program for use in their projects. McMurtry and Guber were grateful for the opportunity to show the students remote sensing at the highest state of the art. McMurtry says, "I trust that all of the students gained some feeling for remote sensing, and that many of the students will utilize remote sensing in their future careers."

McMurtry says that despite the existence of the Office for Remote Sensing of Earth Resources at University Park, the University offers neither a degree program nor a major field of concentration in remote sensing.

PSU cont'd.

At present, only one course in remote sensing is taught. This is taught in the spring semester and involves itself primarily in the analysis of multi-spectral data. McMurtry says that the content of the course is gradually changing and that soon the course will embrace other sensors and other forms of interpretation.

It is McMurtry's conviction that the University should not have an academic department in remote sensing. He believes that a graduate with a degree in remote sensing would have difficulty in finding employment at this time. On the contrary, a graduate with a degree in some conventional discipline, but with a background in remote sensing, would be well qualified for launching a career.

Now that the University's contract with NASA has ended, ORSER is looking to the State of Pennsylvania for contracts. McMurtry and other faculty members frequently confer with officials at Harrisburg to persuade State agencies to use ORSER's services in the conduct of their operations. Thus far, few agencies have shown much interest.

McMurtry is not discouraged, however. He is aware that other states have contracted for remote sensing services in connection with the operations of their agencies, and he continues to stay in contact with the State government at Harrisburg. He views the atrophy of ORSER as a loss of great potential to Pennsylvania. He is most distressed by the prospect of the disuse of ORSER's computer data processing system, now that it is fully viable and ready to accomplish important assignments. Moreover, should ORSER be forced to retrench, faculty members talented in remote sensing research would no longer be available for direction and consultation. McMurtry estimates that annual funding in the amount of \$75,000 to \$100,000 would enable ORSER to function properly and bring great benefits to the State.

PSU cont'd.

McMurtry feels that at present ORSER may not be organized for easy recourse by outside users, and that when this defect is remedied, the funding situation will improve. He further feels that the abilities of remote sensing were overstated to State officials in the past, and that certain failures of remote sensing investigations to live up to expectations have "left a sour taste" in some mouths. Additionally, he realizes that the cost/benefit ratio of remote sensing activities remains a deterrent to general usage.

McMurtry is deeply disturbed by the implications of NASA's policy to discontinue funding at this time to contractors like Pennsylvania State University. He fully appreciates the fact that NASA's primary role is to develop and refine the techniques and instrumentation of remote sensing and then to step aside and let the users take the reins, but he believes the time is not ripe. He fears that the fruits of remote sensing are in danger of withering on the vine. He is convinced that NASA has an obligation to continue financial support for a while longer, until the many agencies of the federal, state and regional governments become motivated by the demonstrated worth of remote sensing to the point that they are willing to take over the funding. McMurtry characterizes the situation this way: "NASA is putting the squeeze on, but the states aren't responding. It's incumbent on NASA to continue its support."

In speculating about the prospects of private remote sensing firms, McMurtry is reminded that some companies have started up and gone out of business. His opinion is that these firms "will have to do a better job" than they have in the past. They will have to specialize in aerial imagery, as opposed to multi-spectral data. At the same time, McMurtry predicts a healthy future for firms dealing in ordinary aerial photography. ORSER

PSU cont'd.

itself has purchased a small amount of imagery data from the Bendix Corporation, but the remainder of its data has come from NASA.

McMurtry expresses his gratitude for the generous cooperation of the Chesapeake Bay Ecological Program Center in making its full services available to the University and to him, and his indebtedness, in particular, to Paul Alfonsi and Richard Dowd of the Center.

The comments of Nanna Bolling, the ORSER imagery analyst and technical reports writer, are of special interest:

"The imagery taken by the NASA Wallops aircraft is superior to that taken by Houston. It's clearer--I guess that's because of the proximity of Wallops and the flexibility of scheduling flights.

"Once, a flight was flown over the wrong area. I think that was on a gypsy moth study.

"NASA Wallops let me go along on a flight one time. It was a profitable experience for me. Until then, I never realized that an airplane has difficulty in following a sinuous flight path. Now, when I plan a flight-line, I make it as straight as possible.

"One of my recommendations is that NASA number its film strips sequentially along the margins. The reason is that after the roll is divided into individual views, I have great problems in handling them as I shuffle them around for different purposes."

UNIVERSITY AND COLLEGE cont'd.

The University of Delaware, College of Marine Science--
Mr. Vytautas Klemas.

The University of Delaware's College of Marine Studies is a center for coastal zone oceanographic research. As the cynosure of scientists involved in such research, visitors in recent weeks have traveled from Spain, India, Japan, Switzerland and several other countries.

Dr. Vytautas Klemas is Associate Professor in the College's Ocean Engineering Group and in Geography. He earned his Doctor of Philosophy degree at the University of Braunschweig, Germany, in 1965. His fields of concern are remote sensing of coastal processes, pollution monitoring and wetlands and land use mapping. He formerly worked for General Electric (Valley Forge, Pennsylvania) on remote sensing investigations of other plants as part of the nation's space program. While at G. E., he devoted a large fraction of his time to service as a consultant at the College of Marine Studies. Finally, he decided to join the faculty.

The following is a list of research projects in which he received assistance from NASA Wallops.

Circulation-Patterns Studies of Delaware Bay during Different Phases of the Tidal Cycle and under Differing Wind Conditions: During overpasses of ERPS-1 and Skylab, ground truth in ascertaining water properties (Secchi depth, suspended sediment concentration, transmissivity, temperature, salinity and water color) was obtained by boats and by helicopters dispatched by NASA Wallops in 1972-73. The application of the project was to predict movement and dispersion of oil slicks. This ability to predict the behavior of oil slicks is important because of the imminence of continental shelf oil-drilling

U. of Del. cont'd.

and the construction of the landward terminals and transfer depots incident to the drilling.

The Mapping of Suspended Sediments and Recording of the Concentration and Distribution of the Sediment in the Upper Layers of the Water Column:
ERTS-1 imagery was used primarily, but imagery from Skylab was also utilized. Wallops' helicopters conducted the water sampling operations. The site of the study was Delaware Bay, 1972-73. The application of the project was to verify and broaden the body of knowledge about sedimentation and its attendant problems, such as the effects on the biota, clogging of channels, impairment of recreational activities and sites, and the deterioration of the esthetics of the situation.

The Determination of Spectral Signatures of Coastal and Estuarine Pollutants:
Laboratory work is being conducted to establish the spectral reflectance (backscatter) of various pollutant substances. These signatures will then be verified in the field. Klemas will request Wallops to lend the College of Marine Studies a special spectrometer for this study and to provide aircraft overflights during 1974-75. This knowledge will enable agencies charged with protecting water quality to monitor contamination over small and large areas. The track and travel of the contaminant may point to the contaminant's origin. Also, the chemical-physical identity of the contaminant may be the index to the source of the pollution (pointing out which industry is responsible). Imagery containing the contaminant's spectral signature should be admissible as prima facie evidence in court cases.

Photo-Optical Determination of Wave Spectra: A study of the structure, composition and behavior of waves at shallow depths as compared with the nature of waves outside the surf zone. The spectra of the internal waves would be derived by optical Fourier analysis of aerial photography and correlated with

U. of Del. cont'd.

the spectra of external waves as recorded by a laser wave profiler from an aircraft or by wave probes atop towers erected beyond the surf zone. In this study, Dr. Klemas proposes to request Wallops to conduct aircraft flights with NASA's laser wave profiler and to take aerial photography during 1975. The information will be useful in studying the interaction of water masses at the continental shelf boundary and in nearby canyons. This is an example of basic oceanographic research.

An Inventorying and Mapping of Vegetative Species in Delaware Marshes:

The study was conducted through the analysis of aircraft multi-spectral imagery. Some of the imagery was garnered by NASA Wallops in 1972-73. The information will be valuable as baseline data for detecting violations of the Delaware Wetlands Act of 1973 and will be of further value in policy decisions concerning the management of Delaware marshlands.

A Study of the Impact upon the Delaware Coastal Environment of Land

Use due to On-Shore and Off-Shore Resource Development: This project is funded by the Bureau of Land Management and by the Office of Naval Research as a Sea Grant. NASA Wallops supplied the study with aircraft infrared imagery, 1972-76. This accumulation of information on the "socio-economic development of the coastal zone" (one of four broad areas of research under the Sea Grant program) will be valuable in making political and management decisions on development of the coastal zone of Delaware.

A Survey of Land Use Change along the East Coast of Delaware:

Data recovered by ERTS-1 and Skylab was buttressed by additional data acquired by underflights by Wallops aircraft. The study divided land use into categories; the percentages of each category were compared with figures of a decade ago, 1972-76. Land use data can be obtained and updated at a fraction of the time and costs required by conventional techniques when it is acquired by satellites

U. of Del. cont'd.

and high-flying aircraft. The data products can be displayed in a variety of forms, all of which are easily utilized by planners and other governmental officials.

Dr. Klemas is involved in some other research, the fruits of which might bring considerable benefits to mankind in general. One such research project is concerned with the remote sensing of chlorophyll in marine waters through the use of laser beams operated from aircraft. Since chlorophyll occurs in abundance in areas of oceanic upwelling, it is in these areas that fish life in greatest numbers gather to feed. According to Klemas, it is a truism that commercial fishermen spend most of their time in areas where they are able to catch only a small amount of fish. This condition could be reversed (and the fishermen would expend a minor portion of their efforts in capturing the greatest number of fish) if a technique of laser-imaging of chlorophyll-upwelling areas from artificial satellites or high flying aircraft could be developed. Klemas has requested the assistance of NASA Wallops in this project. In a world where the food deficit increases each year with the annual rise in population, methods for markedly increasing the harvest of marine feeding grounds could bring high-protein sustenance to malnourished peoples.

Dr. Klemas is also studying estuarine frontal systems. At the common boundary of frontal systems, water masses of dissimilar properties impinge upon one another. Along the frontal zone, foam is generated. Klemas' investigations have revealed the foam to be strongly entrained with such toxic substances as mercury and lead. The foam also bears heavy concentrations of such metals as chromium, copper, iron and zinc. These toxic substances tend to increase in concentration as they ascend the food-cycle ladder. Thus, they pose a real threat to larger fish, waterfowl and man himself. However, this project has not yet required the services of NASA Wallops.

UNIVERSITY AND COLLEGE cont'd.

University of Washington, Department of Anthropology--
Mr. Steve Wilke and Ms. Gail Thompson.

Mr. Steve Wilke and Ms. Gail Thompson of the Department of Anthropology of the University of Washington at Seattle have a contract with the Water Resources Administration of the Maryland Department of Natural Resources to conduct an archaeological study of the Maryland coastal zone.

Mr. Wilke's undergraduate training was in geology and geophysics. He was employed for eight years by a Seattle geophysical company engaged in background studies for the location of large-scale construction projects. Wilke entered the field of remote sensing while working for the Seattle firm. He became further interested in remote sensing when he acquired a thermal scanning instrument from the federal government.

The Wilke-Thompson study began July 1, 1974, and concluded with a report due on July 1, 1975. A second-phase proposal is now being prepared. The title of the original proposal to the DNR was Maryland Coastal Zone Archaeological Resource Management: Archaeological Resources Evaluation and Suggested Guidelines for Planners.

Archaeological Study of the Maryland Coastal Zone: The study had its origin during a period when Wilke and Thompson were doing archaeological investigations (unrelated to the present study) in the Maryland coastal zone. Wilke recognized the extensive development along Maryland's Chesapeake Bay and Atlantic coastline as a grave and imminent threat to the archaeological resource. On voicing his fears to fellow archaeologists from Maryland, he was urged to present a proposal for inventorying and assessing the state's known and unknown archaeological sites and making pertinent recommendations.

U. of Wash. cont'd.

Wilke talked to DNR personnel at Annapolis and was invited to submit a proposal. The DNR personnel were drawing up a management plan for the coastal zone and were pleased to include archaeological considerations. Wilke says that other states are conducting evaluations of their own archaeological resources. New federal and state laws and regulations have been enacted in accordance with a policy to preserve, protect and interpret archaeological resources. In his proposal, Mr. Wilke listed five federal acts and executive orders and one Maryland Antiquity Law.

Wilke says his report will be valuable because it will prevent developers from encountering legal difficulties if they should destroy, even inadvertently, important archaeological sites. Construction companies are always interested in avoiding adverse publicity.

Furthermore, an inventory of archaeological sites would preclude the difficulties which arise whenever archaeological artifacts are uncovered in the course of construction projects. While the archaeologists are conducting a salvage operation, the construction company suffers a costly delay. During the present period of rapidly rising inflation, delay means unanticipated increases in expenditures to the agency financing the project.

As another example of the study's value, Wilke cites the location of a new power plant. When several possible locations are available, the power plant could be shifted to avoid destruction of an archaeologically significant area.

The Wilke study is restricted to the coastal zone because it is this region which is being so intensively developed. It is in the coastal zone that occur the wetlands which are now the subject of much federal and state legislation. To comply with the directives of wetlands policies, the State of Maryland's Water Resources Administration had planned to seek federal funds

U. of Wash. cont'd.

and was pleased to be able to include archaeological considerations in their proposals.

Wilke says that investigations of archaeological resources by remote sensing might also be conducted satisfactorily in locations outside the coastal zone. Remote sensing is suitable to studies of rural areas and even forests, although with more difficulty in the latter case.

When asked about the altitude of the imaging platform from which his data will be derived, Wilke said he had been using U-2 imagery from 60,000 feet. He finds it ideal for the land use aspects of his study and important for obtaining a synoptic view of the study area. Naturally this imagery is superior to the quadrangle maps which are available, and which were produced in the 1940's. Wilke's U-2 imagery is from 1972. For viewing prehistoric remains, however, the U-2 imagery is not suitable. It is not capable of displaying the details which are essential to the search for artifacts. Ground cover frequently hides artifacts.

No low-level imagery of Wilke's study area is available from Wallops. Wilke is utilizing aerial photography of the Soil Conservation Service and a Navy Department office called NISC. This photography was taken at the 3500-foot level, but Wilke feels that any photography taken between 3000 and 5000 feet would suit his purposes. At these altitudes, shells (midden debris) are readily apparent because of their "white reflectance." Wilke has inquired at NASA about the use of side-scanning radar and thermal infrared flights. He realizes, however, that he will have to do extensive ground-truth work. In 1973-74, Wilke personally located 80 new archaeological sites in Kent County. To date, Wilke and Thompson have located a total of 180 new sites, some of these via Wallops imagery.

The primary importance of the Wallops imagery to Wilke lies in its utility

U. of Wash. cont'd.

as a base for making recommendations about land use planning. Secondly, the imagery will be important because it will enable the state authorities to permit or prohibit the location of land developments at certain sites according to the archaeological resources involved. An aim of his study is to establish a predictive model for location of archaeological sites. In explaining "predictive model," Wilke says that the model is both qualitative and quantitative. To construct the predictive model, he has categorized the Maryland coastal zone into five types. At the conclusion of his investigations, Wilke will know that archaeological sites will occur frequently in certain environmental situations, but never in others. Using the data of the Wilke study, the authorities will be able to predict whether development could be safely conducted in a particular location.

In commenting on the time-schedule of his study, Mr. Wilke says that the best time for on-site inspections is in the spring. The archaeological artifacts which Wilke expects to discover will consist of shale pits, lithic debris, parts of stone axes and the tips of arrow heads and other implements. Non-artifact evidence for which Wilke will be looking will be organic stains in the soil. Wilke says that land owners, often farmers, have a strong attachment to their land and are proud of their land's archaeological importance. They readily grant permission to investigating archaeologists. However, during the period when farm crops are maturing, these farmers are understandably reluctant to permit activity in the fields.

Wilke says that the archaeological resource of Maryland's coastal zone is from the culture of Prehistoric Indians. The Smithsonian Institution, using radio-carbon dating methods, has ascribed an age of 5560 years to oyster shells recovered by Wilke. The style of recovered artifacts indicates that an Indian culture flourished in the Maryland coastal zone as long as

U. of Wash. cont'd.

10,000 years ago.

In the course of the investigation of Prehistoric Indian archaeology, Wilke expects to recover artifacts from America's colonial period. Wilke considers these recoveries to be of importance, since Maryland's citizens are currently interested in piecing together the state's early history.

Wilke says that it is important for trained archaeologists to inventory the coastal zone. Laymen and amateur archaeologists are likely to overlook or destroy valuable evidence of early cultures. Wilke cited the fact that shell piles, considered by laymen to have been deposited by high tides in recent times, are actually food discards by ancient Indians.

Wilke agrees with the interviewer that his study will have political overtones. Perhaps the men who write the laws of the future will be motivated by the Wilke data to enact legislation to insure the preservation of archaeological remains. In any event, Wilke expects that the federal and state agencies will give some degree of consideration to the archaeological resource, and that they may even set aside certain "zones of exclusion."

In commenting on the economic aspects of the archaeological resource, Wilke says that he observes rising interest of the general public in archaeology. The attendance figures at archaeological centers of public visitation are increasing yearly. The burial grounds at the Island Field Site, South Bowers, Delaware, is a case in point; it is gradually becoming a legitimate tourist attraction.

Wilke feels that the State of Maryland is demonstrating a serious interest in the archaeological resource by financing his study. If the higher echelon of State authority reacts similarly, then legislation might be enacted to reinforce the present laws.

When Wilke views the situation from the standpoint of "cold economics,"

U. of Wash. cont'd.

he recognizes that archaeological considerations are likely to be overwhelmed by the magnitude of a \$100-million-dollar power plant. Nevertheless, the construction of the plant might be delayed or the site shifted slightly to permit archaeological salvage operations to be carried on.

Even though a concern for the archaeological resource is mandated by law, Wilke realizes that archaeologists must proceed carefully. He believes that the archaeologists can achieve the most by participating in the formulation of land use planning. This participation should eliminate the necessity for rush salvage jobs, a type of activity which diminished the importance of many archaeological investigations in the past. The equipment and techniques of the present era are far superior to that of the 1930's.

Wilke says that it is particularly important that the Maryland coastal zone have its archaeological resource investigated at this time because it is a region of dynamic development. Otherwise, a significant portion of the archaeological resource will soon be obliterated, and the opportunity to accumulate an accurate and complete record of the coastal zone in prehistoric times will be lost.

Wilke says that the Chesapeake Bay did not exist 10,000 years ago. However, the Susquehanna River did exist, and it was the determining geomorphic entity in the culture of the inhabitants. The aborigines had to alter their life pattern when the Atlantic Ocean rose and created the Chesapeake. They had to adapt themselves to the changes that resulted from the transition of an environment surrounding a broad, freshwater river to one surrounding a large, brackish marine bay. The Chesapeake Bay has inundated and destroyed much of the remains of the early culture.

UNIVERSITY AND COLLEGE cont'd.

Virginia Polytechnic Institute and State University, College of Agriculture--Dr. David Pettry.

The College of Agriculture of VPI & SU has been under contract with NASA Wallops for five or six years--essentially since Wallops initiated its remote sensing operations. VPI is now working under its second three-year contract. The contract was awarded so that Wallops could develop and refine its techniques and equipment and so that the University could conduct research on agricultural, soil and environmental problems.

Complete descriptions of all VPI/Wallops cooperative projects are contained in two publications: (1) "Use of Remote Sensing in Agriculture" (July, 1970--June, 1973) by Pettry, Powell and Newhouse and (2) "Soil and Morphology of the Eastern Shore of Virginia," a Master's Degree Thesis by Daniel Bliley. The publications are on file at NASA Wallops.

Descriptions of the work involving NASA Wallops imagery follow.

Soils and Morphology of Virginia's Eastern Shore: Bliley investigated the curious geomorphic entities known as "Carolina Bays." The bays are shallow, ovate depressions appearing off-shore and on-shore along the Atlantic coastline from Delaware to Florida. Their diameters vary from 200 yards to about one mile. In Northampton and Accomack Counties, the VPI investigators located 155-160 bays, many of them previously unrecognized.

The origin of the bays is an enduring mystery. A dozen or more possible origins have been proposed: wallowing whales, impacting meteorites, etc. Scientists, while rejecting these theories, have been slow to supply the answer. The bays were so named because they were first studied in the Carolinas. Dr. Pettry thinks the bays were formed by oceanic wave action at some point

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in the remote past. The scientific community, in general, now regards the bays as slowly-eroding, relic landscape-features. Their significance is that they are clues to the evolution of landscape forms. (Pettry believes they may date from the Miocene Era.)

Because the bays are an interesting mystery to the laymen and scientists alike, the announcement of Bliley's study was publicized nationally by United Press and internationally by Reuters News Service.

The Identification of Plant Species by Spectral Signatures: Dr. Pettry says that this program is progressing satisfactorily. He admits that some of the literature has expressed pessimism, especially in tree identification, but that, all in all, signatures are gradually being established for a host of plants.

Other nations are engaged in remote sensing of plant pathologies, too. Some of these nations are ahead of the United States in the pre-visual detection of plant disease and nutrient deficiencies.

VPI has been working on establishing the spectral signatures of various agricultural crops of Virginia. Each phase of a crop's development produces a different signature. Furthermore, each signature is modified by such parameters as soil type, temperature, rainfall, sun angle, fertilization, crop spacing, etc.

Model signatures are being derived which can be applied to crops all along the Eastern Coastal Plain. Pettry says that signature-work has been done on Irish potatoes, soybeans, corn, beans, peanuts, cover crops, grasses and rye.

In the early days of signature-work by various researchers, many investigators were too optimistic about predictions. This caused much disappointment when success was slow in coming. Now, however, definite

VPI & SU cont'd.

progress has been made. VPI has already established signatures associated with blight diseases. Pettry says that a manual of these disease-signatures might be prepared.

Pettry explained that the remote sensing research into the agriculture of the Eastern Coastal Plain, extending from the Boston-New York district to Norfolk, is important because it is there, on just two percent of the nation's land area, that 40 million people live. Trends disclose that the amount of land available for agriculture is steadily shrinking. To feed the populace, the producers have had to increase the yield by farming more intensively.

In 1970 and 1971, Pettry and other scientists engaged in a cooperative research project at the Virginia Truck and Ornamentals Research Station, Painter, Virginia. The initial objectives and methodology were designed to develop and evaluate multi-spectral sensing techniques for the detection of plant species and associated diseases, soil variation and cultural practices under natural environmental conditions.

The Painter Station is a 100-acre experimental farm arranged in rectangular fields. It is located in an intensive vegetable crop and ornamental production area. Excellent ground control and detailed records of previous practices have been maintained for the station. A system has been installed to continuously monitor environmental factors that influence the remote sensing. Solar radiation, an important variable, is continuously monitored as are air, soil and plant temperatures, relative humidity and wind speed and direction. The data are recorded on a multichannel recorder housed in an instrument building near the center of the research site.

Pettry has high hopes for increasing yield through the knowledge derived from the creation of "dynamic models." In this line of research, experimental

VPI & SU cont'd.

crops are raised under the continuous surveillance of sensors which are automatically recording environmental and weather conditions. The scientist then integrates the sensing-data with all other pertinent data. The combined data are then digitized for computer storage and retrieval. Meanwhile, the crops are being imaged from aloft at all stages of development. By correlating the imagery with the computerized data, a predictive model is generated which can forecast yield.

The enormous benefit of this knowledge is patent. Pettry says that both high and low imagery are valuable in agricultural research, but that different aspects (color, shape, etc.) are important to the interpretation of each. In higher-altitude imagery, shape is more important than color.

VPI's Research Division Report 71, co-authored by Dr. Pettry, contains this relevant quotation about remote sensing: "Entire new areas of agricultural research are being opened by this modern technology. Dramatic advances may occur. . . ."

Identification of Soil Types: Pettry has been able to identify and map soil types by remote sensing. This application of remote sensing to matters of the public health is important, since soils are utilized for the dilution, filtration and general purification of raw and partially treated sewage effluent and domestic waste in order to reduce the concentration of pathogenic organisms, nutrients and organic materials. Destruction of pathogens must be accomplished by the soil.

Soil information is eagerly sought by planners in planning and zoning programs. Pettry is engaged in remote sensing studies to obtain soil information about the Virginia Beach region, a rapidly developing portion of the Norfolk-Portsmouth-Newport News-Hampton metropolis. Virginia Beach's population will soon reach 275,000 to 300,000 people. Moreover, Virginia Beach is a

VPI & SU cont'd,

resort attraction which draws 200,000 visitors each summer. The population density is as great as anywhere in the nation (according to Pettry).

Virginia Beach has a history of high agricultural production and is especially known for the production of swine and soybeans. Pettry's data will be utilized by planners of the City of Virginia Beach in land use classification projects. The data will point out areas susceptible to septic tank failures. Pettry was imported for the studies because Virginia laws specify that a soils scientist must be consulted in matters of land use and development.

Identification of Septic Tank Failure and Soil Pollution: Pettry's remote sensing imagery will be able to identify instances of septic tank failure and areas of sewage pollution. In most cases, photographic imagery will detect the above conditions by locating sites of unusually lush vegetation.

Pettry's imagery once accidentally discovered a leaking sewage treatment lagoon. The lagoon had been leaking for a prolonged period unknown to anyone. After the discovery, authorities ordered the lagoon's operators to repair the defect, and a serious source of contamination was terminated.

Soil pollution is a problem of great magnitude all over the nation. A 1968 survey indicated that the daily per capita production of solid wastes was 5.3 pounds. By 1980, the production of solid wastes will amount to 235 million tons a year. At least 90 percent of the solid wastes in the United States are disposed of on land.

Peanut Cythrodium Black Rot Disease Study: Virginia is an important producer of peanuts. The state's main variety is a cocktail peanut, a select type of Spanish peanut. The center of Virginia's peanut crop industry is located around the city of Suffolk.

VPI & SU cont'd.

Only a few years ago, an unfamiliar disease suddenly began to infest the Virginia peanut crop. Because it resembled the black rot disease which is a chronic and formidable enemy of wheat, the new disease became known as the Peanut Black Rot Disease. It is a fungus which attacks the plant's fruit and roots.

Although its earliest appearances were isolated and of small scope, the advent of the disease caused immediate consternation in the peanut industry. The disease has spread predictably and the extent of its depredations has grown. At several locations, it has killed 70 to 90 percent of the plants within the infested area. The disease has now been found on soybeans, and perhaps it will soon infest other crops.

By the time that farmers are able to detect Black Rot, the plants are already doomed. The only course of action is removal of the affected plants to prevent the disease's spread. (Plant pathologists believe that the disease is transported aboard farm vehicles and machinery.) If the situation warrants, quarantine regulations will no doubt be instituted.

Reports by farmers may only account for ten percent of the disease's occurrence. A better method of surveillance is needed. VPI & SU is working on the development of techniques for monitoring the Peanut Black Rot Disease by remote sensing. The project has become one of the many research studies being carried on under the University's cooperative program with NASA Wallops' Chesapeake Bay Ecological Program.

Dr. David Pettry and Dr. Norris Powell of the Department of Agronomy are working on the Black Rot study. They are interested in learning how to detect the Rot's presence at the pre-visual stage via aerial remote sensing.

Identification of Forest Types: Attempts were made to discriminate forest types utilizing scanner data. Unfortunately, poor results were obtained,

VPI & SU cont'd.

possibly because the study areas were composed almost entirely of pines.

Expansion of the Data Base to other Chesapeake Bay Region Areas:

The methodology and parameters developed at the Painter Agricultural Research Station were extended to broader areas of the Chesapeake Bay region for future application through remote sensing flights over: the Tidewater Research and Continuing Education Center at Holland, Virginia; the Eastern Virginia Research Station at Warsaw, Virginia; the Hundley and Blackwell experimental farms near Warsaw, Virginia; the University of Maryland Research Station near Salisbury, Maryland; the University of Delaware soil fertility demonstration plots at Millsboro, Delaware; and the Southern Piedmont Research and Continuing Education Center at Blackstone, Virginia.

Pettry says that the information acquired through his remote sensing studies is being used by plant physiologists and agricultural engineers. He is also aware that state and county planners are utilizing his Virginia Beach data in the preparation of land use maps. Furthermore, the Carolina Bays study prompted requests for information from as far away as Japan.

When the interviewer asked him to comment in general on NASA Wallops and its operations, Dr. Pettry affirmed the value and utility of remote sensing, the excellence of Wallops' instrumentation and cooperation and the University's readiness to continue the association with NASA. His lone recommendation was that a course in data use be implemented at Wallops for the purpose of instructing investigators who wish to use the Flight Center's remote sensing services in their research.

C. UNIVERSITY AND COLLEGE cont'd.

5. University of Maryland, College of Agriculture, Department of Agronomy--Dr. John Foss.

Dr. John Foss of the University of Maryland's Agronomy Department is involved in Mapping Soil Types in Maryland's Tidal Marshlands. His study is part of the College of Agriculture's on-going research program. The intent of the study is to develop methods for mapping soil types in wetlands. The study will be presented as a Master's Degree thesis, presumably by Foss' research assistant, who is working on the study under the direction of Dr. Foss. The study will be funded by the State of Maryland, although other sources of funds may become available.

Dr. Foss became interested in using remote sensing when he enrolled in the IARS course at NASA Wallops. He and two of his students took the course. Foss is now examining the imagery on file at NASA. This imagery may be sufficient for his purposes, but if not, he may request some additional flights. Thus far, he is finding that color IR imagery is best suited to his identification/classification program. Foss believes that natural color imagery would also be adequate. The examination of imagery taken at various seasons is important to his study, which is presently involved with marshlands of restricted dimensions. The study is focusing on marshes in Worcester County and along the Patuxent River, thus embracing both coastal and estuarine marshes.

Foss says that remote sensing has been used to map upland soil types in Maryland, but until now, little or nothing has been done about mapping tidal marshland soil types, at least in Maryland. Outside of Maryland, work has been done in Connecticut, Rhode Island, Louisiana, Texas and Florida. Foss conceded that much mapping of tidal marsh vegetation has been done. He stated that the

U. of Md., Dept. of Agron. cont'd.

type of vegetation which overlies a soil is a reliable index to the type of soil. Perhaps it is reliable 90-100 percent of the time. Foss will no doubt use vegetative-typing to identify soils, but he would like also to be able to identify the soils directly. He would prefer to use the vegetative-typing method as a check on his own findings. Although vegetation is a reliable index to soil type, Foss realizes that at times the vegetation might bear no relationship to the soil type. Foss stated that the presence of water atop the marsh soils may frustrate identification of the soils. He would prefer using images of the marsh when water is absent (during periods of low tide or during dry seasons).

Foss said that his study should be useful in the development of the coastal areas. His information could provide advice on where development should occur because of the soil characteristics. Soil information would also indicate where the marshlands are trafficable, where roads could be constructed and where foot paths could be established for recreational purposes. Foss believes that the results of his study will also be of considerable interest to people engaged in land use planning and to wildlife agencies. He further discussed the relationship of the study to wildlife explaining that a knowledge of a soil's type would indicate whether it could support the plant life which would sustain wildlife. This information would be valuable in determining the best location for a wildlife refuge. Furthermore, a refuge could not be satisfactorily located on soil where human visitors couldn't safely travel. Foss added that certain soil types spontaneously produce sulfuric acid. The emission of the acid would necessarily affect the ecology of the region.

Although Foss' investigation can be regarded as a trial study, he believes that if it is successful, a complete mapping of Maryland's marshland

U. of Md., Dept. of Agron. cont'd.

soils will be conducted. Maryland has 300,000 acres of tidal marshlands. Foss implied that he had ambitions of doing marshland-soils mapping in other states than Maryland.

The imagery which Foss has been examining was taken at an altitude of 10,000 feet, but he believes that any imagery taken between 5000 and 10,000 feet would be satisfactory. Without the use of remote sensing, Foss said it would be very difficult for him to conduct his study. To obtain data by surface investigation would require him to visit areas which would be dangerous to life and limb. He praised the cooperative spirit of NASA during the course of his research and was pleased with the quality and effectiveness of the LARS course.

UNIVERSITY AND COLLEGE cont'd.

University of Massachusetts, Department of Botany, Cooperative Park Studies Unit with National Park Service--Dr. Paul Godfrey.

The University of Massachusetts has become associated with NASA Wallops through studies conducted by the faculty and students of the University for the National Park Service. The University has carried on investigations for the NPS at Cape Cod National Seashore in Massachusetts and its faculty and students have been involved with studies at Cape Hatteras and Cape Lookout National Seashores in North Carolina and at Assateague National Seashore in Maryland.

To administer the series of studies for the National Park Service, the University has created a group called the Cooperative Park Studies Unit with offices in Clark Hall on the Amherst campus. Dr. Paul J. Godfrey, assistant professor of the Department of Botany is Leader of the Park Studies Unit.

Dr. Godfrey holds a Ph.D. degree in botany and plant ecology from Duke University. He teaches courses at the University in coastal ecology, autecology, plant geography, natural history and plant ecology. Before joining the University of Massachusetts, Godfrey was employed by the National Park Service as a biologist and research biologist in the Office of Natural Science. His research interests focus on the coastal, physiological and alpine aspects of plant ecology.

He became enthusiastic over the capabilities of remote sensing when he happened to see some NASA imagery while working on a study at Cape Lookout. Comparing the NASA imagery with the standard black-and-white aerial photographs he was using, Godfrey immediately recognized the superior virtues of the NASA photography.

Since then, Dr. Godfrey and the University's Cooperative Park Studies Unit have carried on a number of studies with the cooperation and support of the National Aeronautics and Space Administration, notably with the NASA Wallops Flight Center.

The following is a list of publications based on individual studies in which data were recovered through the remote sensing operations of the Chesapeake Bay Ecological Program:

Effects of Hurricane Ginger (Fall, 1971) on the Barrier Islands of North Carolina by Robert Dolan and Paul Godfrey, an article appearing in the April, 1973, issue of the Geological Society of America Bulletin. This study demonstrated that the impact of a severe storm on man-stabilized islands is far more destructive than on unmodified islands. This conclusion has important geologic, ecologic and land management implications. Color infrared aerial photographs by NASA Wallops accompanied the article and were used in the study.

Man's Impact on Barrier Islands of North America by Robert Dolan, Paul Godfrey and W. E. Odum, an article appearing in the March-April, 1973, issue of the magazine, American Scientist. A case study of the implications of large-scale manipulations of the natural environment. Credit for color aerial photography used in the study and the article was given to the Chesapeake Bay Ecological Program, NASA Wallops.

Some Estuarine Consequences of Barrier Island Stabilization, a scientific paper by Paul and Melinda Godfrey presented in the Proceedings of the 2nd International Estuarine Conference, Myrtle Beach, South Carolina, 1974. One of several studies on which the National Park Service is basing its decision to discontinue expensive construction projects to protect roads, power lines, motels and the other cultural artifacts which occupy the barrier islands.

Barrier Island Ecology of Cape Lookout National Seashore and Vicinity, North Carolina, a paper by Paul and Melinda Godfrey appearing in the Proceedings of the AAAS Symposium of Research in the National Parks, 1974. A study to obtain baseline information on the ecology of a feral barrier island which has recently become a National Seashore and will be subjected to the impact of human visitation.

The Role of Overwash and Inlet Dynamics in the Formation of Salt Marshes on North Carolina Barrier Islands, an article in the Ecology of Halophytes, Academic Press, New York City, 1974. A study of the ecological significance of salt marshes, a crucial habitat where marine life spends part of the life cycle and on which the commercial and sports fisheries industries depend.

The University of Massachusetts engaged in other studies in which the remote sensing services of NASA were utilized, although the writer is uncertain of the extent of the role played by NASA Wallops:

An Assessment of the Value of High Altitude Remote Sensing for Mapping Underwater Vegetation conducted by Dan Stetka of the University of Massachusetts for the National Park Service in 1972. Successful mapping of vegetation at depths of 2-3 feet was accomplished.

Vegetative mapping at Cape Hatteras. This 1973 project used NASA imagery already in existence. The ground truth aspect of the project was performed by Cheryl Ann McCaffrey. In 1975, Ms. McCaffrey used the services of the Chesapeake Bay Ecological Program on a study of the Virginia Coast Reserve for The Nature Conservancy.

A secondary use of the imagery from the above study was by Dr. Godfrey when he used the imagery for Mapping Salt Marshes of Cape Hatteras to Determine their Successional Stage and to Estimate Productivity.

U. of Mass., CPSU cont'd.

The Park Studies Unit is not the only division of the University of Massachusetts interested in conducting scientific studies with the cooperation of the Chesapeake Bay Ecological Program Center. Dr. Alan W. Niedoroda, a member of the faculty of the Department of Geology, is also laying plans. Dr. Niedoroda, as Director of the Coastal Research Center, wishes to use the data of NASA Wallops for Studying the Geology of the Massachusetts Coastal Zone.

The instructional and educational services of NASA Wallops were made available to two groups from the University's Park Studies Unit in the summer of 1974. When the first group returned to the University with glowing accounts of Wallops' techniques and equipment, Dr. Godfrey was motivated to accompany the second group of visitors. The potential of LARS elated him and he "immediately saw the great value of the multi-spectral approach to mapping vegetation."

Dr. Godfrey and all the personnel of the University's Cooperative Park Studies Unit are enthusiastic about the prospects for a future program of studies to be undertaken as a joint venture of the State of Massachusetts and the Chesapeake Bay Ecological Program Center. A description follows:

The State of Massachusetts has plans to enter into a program of studies of considerable magnitude with the National Aeronautics and Space Administration. The title of the proposed program is Ecological Evaluation and Mapping of Massachusetts Estuaries Through the Use of Remote Sensing.

The program has the strong support of Secretary Murphy of the Massachusetts Office of Environmental Affairs. In further support of the projected program, the office of the Governor of Massachusetts has corresponded directly with Dr. James C. Fletcher, NASA Administrator. The program would be financed by federal funds and would be congruent with a current research program at Cape

U. of Mass., CPSU cont'd

Cod National Seashore being conducted for the National Park Service by the University of Massachusetts' NPS Cooperative Park Studies Unit.

The Ecological Evaluation and Mapping of Massachusetts Estuaries promises economic benefits to a state which is admittedly in financial straits. The studies program should produce the data necessary for the management of intertidal areas to retain and increase the state's commercial fishing industry, since, according to Dr. Godfrey, 90 percent of the coastal fisheries is dependent on eelgrass. Massachusetts is determined to avoid the fate of Connecticut, adjacent to the south, where development in coastal zones caused a calamitous decline in the commercial fishing industry.

The Massachusetts Estuaries Studies Program would identify productive and non-productive coastal zone areas. Presumably, productive zones would then receive legislative protection, and non-productive zones would be reserved for future development.

The use of three types of NASA data is anticipated: (a) satellite four-channel multi-spectral, (b) aircraft twelve-channel multi-spectral and (c) infrared aerial photographic. Also anticipated is the use of the Wallops Flight Center's IARS Terminal for the automatic processing of multi-spectral information.

When asked to comment on the value of NASA's remotely sensed imagery to him, Godfrey said, "The scale is handy for use in our studies. And it is better than conventional photography because it takes a long time to train an aerial photography interpreter."

Godfrey suggested one improvement he would like to see implemented at the Chesapeake Bay Ecological Program Center: "the accessibility of a multi-spectral scanner would be important."

U. of Mass., CPSU cont'd.

In commenting on the announced intention of NASA Wallops to discontinue its remote sensing services after the pioneering phase is ended, Godfrey said, "I devoutly hope that Wallops doesn't tell its users, 'Okay, we've shown you how it can be done. Now go out and hire a private firm in remote sensing to carry on your work in the future.'"

Godfrey's philosophy is that the states and their agencies will always be too poor to hire private firms. He believes that whenever the service is in the public benefit, NASA should continue it.

UNIVERSITY AND COLLEGE cont'd.

University of Massachusetts, Department of Botany, Cooperative
Park Studies Unit with National Park Service-- Richard Nathhorst

Richard Nathhorst is a member of the University of Massachusetts' Cooperative National Park Service (NPS) Studies Unit. He has visited Wallops to take instruction in the LARS course and has worked on cooperative studies with NASA Wallops.

Beach Stabilization ^{at} Cape Hatteras: Nathhorst says that Dr. Paul Godfrey, associate professor of the University of Massachusetts Botany Department, participated in the Cape Hatteras NPS studies which recommended against continuing the beach stabilization and nourishment projects. At Cape Hatteras, the NPS spent several millions of dollars to construct a protective dune system which really couldn't work over a protracted period of time. Moreover, the United States government spent several more millions of dollars in Federal Disaster Relief Funds to help in the rebuilding of damaged hotels, roads, etc., which were promptly destroyed again when the Atlantic coast suffered a nor'easter (storm).

The seashore, according to Nathhorst, can be managed in some degree if the managers are careful to operate in harmony with the natural processes; i. e., buildings can be erected on barrier islands if the builder locates them on the soundward side of the island where accretion is occurring and avoids the retreating shores on the ocean side. Nathhorst says that groins will still be of value in certain instances, even though they operate under a "rob Peter to pay Paul" mechanism. He says that the federal government may have to use groins at Sandy Hook in New York State. Nathhorst has conducted studies at Cape Cod where beach erosion hasn't been a problem. He and Godfrey have done vegetation studies here and elsewhere.

Nathhorst says that he and Dr. Godfrey want to investigate how remote sensing can be used as a research and management tool. They believe that remote sensing should be more widely used in these roles, and that its potential has not been exploited. He believes that the NASA remote sensing program should be publicized more, and that the program's services would be used much more extensively if their availability were generally known. He says that the imagery library at NASA would benefit many agencies, governmental officials, scientists and individuals who are presently unaware of the program's existence and capabilities.

Quotations by Nathhorst:

"Even the low resolution 9-inch infrared imagery is very valuable. The user needn't own an expensive light table or elaborate viewing equipment. Just by examining the photo against the office window, great work can be done."

"LARS can be of great advantage to small governmental units who haven't the financial and manpower resources to manage large land-areas over which they have responsibility."

"We find that NASA imagery is of the greatest worth in providing us the opportunity of noting long-term changes through comparison with aerial photographs taken several decades ago."

UNIVERSITY AND COLLEGE cont'd.

University of Massachusetts, Department of Botany--Cheryl Ann McCaffrey.

Cheryl Ann McCaffrey is a graduate student in the Department of Botany at the University of Massachusetts. During her university career, she has been engaged in several scientific studies at various National Seashores along the Atlantic coast for the National Park Service. These studies are the product of an alliance between the University and the NPS. Because of the large scope of the studies, the University has organized a special group under the leadership of Dr. Paul J. Godfrey, assistant professor in the Department of Botany. The group is named the Cooperative Park Studies Unit.

When The Nature Conservancy purchased a dozen or so barrier islands off the Atlantic coast of Virginia's Eastern Shore, it felt obligated to have the purchase assessed ecologically before establishing a management policy. In the search for a qualified investigator, Dr. Godfrey was contacted. He recommended that Ms. McCaffrey be given the assignment, and this was done.

In January, 1975, McCaffrey had visited NASA's Wallops Island Flight Center where she enrolled along with Dr. Godfrey in the five-day IARS course conducted by Dr. Harold Maurer. At the time of her visit to Wallops, she observed the remote sensing operations of the Chesapeake Bay Ecological Program. She recognized how valuable the imagery of the Ecological Program's repository would be to her study for The Nature Conservancy, but she did not request to use the imagery because she feared "it might be too expensive." However, the Ecological Program Center did make the appropriate imagery available to her.

McCaffrey says that the objective of her study of the Conservancy

U. of Mass., Dept. of Botany cont'd.

purchase, commonly referred to as the Virginia Coast Reserve, is to map the vegetation of the islands according to types of plant communities. She has not yet settled on a title for the study, but she has tentatively named it A Vegetation Analysis of the Virginia Coast Reserve. The study is to require six months and a report will be due in July, 1975. At present (late April), she is "categorizing and lumping."

McCaffrey described the preparation of her report to the Conservancy step-by-step:

1. Each color infrared photograph is magnified three times.
2. A tracing of the magnified photograph is done on an acetate medium. Plant communities are identified and labeled.
3. A blueprint is made of the acetate tracing. The blueprint is used for field work, the acetate tracing remaining in the office.
4. The blueprint is taken into the field for ground truth gathering. Information is pencilled onto the blueprint.
5. The annotated blueprint is returned to the office where it is correlated with the color infrared photography. Data are assembled and plants are sorted into groups. Species are lumped and split.

(For examining the imagery, McCaffrey constructed her own light table from rough lumber. Equipped with a light source, a pane of frosted glass and spools at each end for passing the film roll, the table works admirably for the study's purpose.)

6. The dominant species of each community is determined. Variations in the composition of communities are noted.
7. The final version of the mapping is transferred to the acetate tracing with labeling and a legend. Various types of information are included by the use of overlays.

U. of Mass., Dept. of Botany cont'd.

8. A text is written to accompany the maps. The text contains further details about the species and an explanation of community types. Communities are described island by island, with variations indicated. Notable features of the vegetative landscape will be mentioned; e. g., "only place where red maple occurs."

Successional trends will be described and suggestions will be made concerning the management of the islands. The plants of each island will be listed by zones and by abundance. A list of all animal life (aquatic, avian, mammal and insect) observed during ground truth work will be included. (In conjunction with the animal list, transects will be performed if time permits.) Photographs of representative plant communities will also be included. A bibliography will conclude the textual portion of the report.

McCaffrey believes that the results of her study will be of value to later researchers. She hopes that her data will be preserved in some form that will enable any interested person to obtain and utilize the material. She may publish some portion in a journal like Chesapeake Science.

The NASA Wallops imagery which McCaffrey is using is 9-inch square color infrared acquired from 10,000 feet by a C-54 aircraft. She also refers frequently to a highly enlarged Wallops' black-and-white wall photograph of Parramore Island, the Reserve's largest island.

Asked what she would have done if she had not been able to obtain imagery from NASA, McCaffrey says she doesn't know. "I don't even know if any other photography is available."

Asked if she had used any other of NASA's services during her study, McCaffrey says that the nature of her work precludes this, although she suggested she had made one or more visits to Wallops in the early stages of the study. She hasn't needed any special equipment, except for the

light table.

In lauding the virtues of the infrared imagery, McCaffrey expresses her wonderment at its capacity for depicting vegetation limits so precisely. "My tracings from the imagery surpass the accuracy of the area's topographical maps. And I can plot boundaries exactly."

In responding to the interviewer's request for general comments about the imagery, she says: "It has no inherent deficiencies. Perhaps the unfamiliarity of the user might cause some difficulties. And, of course, the resolution--even of color IR--is limited. Vignetting, the distortion at the edges, is a problem. But I've had good success by visually compensating for the vignetting."

McCaffrey says that the decision to use imagery of the Chesapeake Bay Ecological Program was not hers. She believes that Gerard "Rod" Hennessey, Director of the Virginia Coastal Reserve for The Nature Conservancy, made the decision.

In discussing legal implications of her study, McCaffrey says, "Maybe my charting of differences between high marsh wetlands and low wetlands will be used by the Conservancy to establish the Reserve's boundaries."

McCaffrey believes that her data on the Virginia barrier islands are the only available, although she has been told two similar studies had been done in 1963 and 1965 on Smith and Parramore Islands.

According to McCaffrey, her report will be of interest to the fish and wildlife agencies of the federal and state governments. She considers the report's greatest value may be historical, since it provides a record of present conditions on the barrier islands for future comparisons to determine evolutionary changes.

Her study may have recreational and management implications due to the

U. of Mass., Dept. of Botany cont'd.

fact that she has observed an overpopulation of deer on certain islands. Apparently the browse available isn't sufficient for the number of the animals inhabiting the islands. McCaffrey has seen several stunted specimens. Based on these observations, her report may contain a recommendation that limited public hunting be permitted on islands with excessive deer populations.

Asked who, other than The Nature Conservancy, might utilize her data, McCaffrey replies, "Universities and individual researchers will be interested in referring to it, since the physical and ecological processes here are similar to those elsewhere. In addition, geologists and general biologists should find it of interest."

McCaffrey's opinion is that remote sensing may forever be too expensive for most researchers, and that NASA should provide services without charge to non-profit organizations and public agencies whose work is to the public benefit.

Interviewer's note - The Nature Conservancy, a non-profit organization, operates on modest financing. The office at the Virginia Coast Reserve occupies a wooden frame residence and is starkly furnished. McCaffrey lives in a dilapidated frame house for which the owner asks no rent--but the house has no indoor sanitation facilities.

McCaffrey laughs at the interviewer's question: "Asking whether I think remote sensing has a future is like asking the Wright Brothers whether flying has a future."

UNIVERSITY AND COLLEGE cont'd.

University of Virginia, Department of Environmental Sciences--
Dr. Bruce Hayden.

Dr. Hayden is a member of the faculty of the Department of Environmental Sciences at the University of Virginia. He teaches courses in meteorology and climatology.

Dr. Hayden says that primarily the University of Virginia's use of NASA Wallops remote sensing services has been in conjunction with the University's role as a Cooperative Park Studies Unit under contract to the National Park Service.

Research on National Seashores: Research conducted by personnel of the University's Department of Environmental Sciences has concentrated on the National Seashores. Investigators are observing and recording changes in coastal environment and assessing the impact of various causative factors to provide information and recommendations for management on both a regional and national basis. Specifically, the researchers are concerned with defining the nature of variability so that decisions can be made.

The National Park Service's management of its National Seashores has attempted to honor commitments made many years ago. In the 1950's the NPS promised to exert itself to protect cultural resources located along the National Seashores. Protection has taken the form of groins, sand fences, artificial dunes and beach nourishment.

The program of protection has been costly. At Cape Hatteras alone, \$25,000,000 has been spent. During the 1960's, the NPS began to suspect that the protection program was not accomplishing its objective. The tentative conclusion was that protective measures were in direct conflict with irresistible natural processes. To document the conclusion, the NPS

U. of Va., Dept. of Environmental Sciences cont'd.

has funded long-term studies by outside scientists and universities. Personnel at the University of Virginia have conducted contract investigations of coastal processes for the NPS for a number of years.

The first cooperative arrangement between the University and the NPS came in the 1960's when Dr. Robert Dolan of the University was hired by the NPS to do an assessment study of the Cape Hatteras National Seashore.

Presently, coastal studies for the NPS are being carried on by such members of the faculty as Dr. Bruce Hayden, Dr. John Fisher and Jeffrey Heywood. These men are supported by additional staff.

In continuing studies of coastal variability at the Cape Hatteras and Assateague National Seashores, University researchers are compiling an historical record of the coastline as revealed by aerial photography. Present photographs are being compared with photographs taken in previous decades, as early as the 1930's.

The early photographs were taken by various agencies, including the Department of the Navy and the Soil Conservation Service. Today, at least 85 percent of the photography is acquired by aircraft from the NASA Wallops Flight Center. Dr. Hayden comments that the scale of the NASA Wallops photography is especially well-suited to the purposes of his Department's research.

Dr. Hayden says that the data produced by the coastal studies have become so overwhelmingly convincing that the National Park Service enunciated a major change in management policy in 1974. The NPS announced its unwillingness to continue a wholesale program of beach protection which was extremely costly and at the same time doomed to failure over an extended period.

The announcement caused great consternation among citizens and commercial firms whose interests were affected by the policy change. Since then, the Park

U. of Va., Dept. of Environmental Sciences cont'd.

Service has modified slightly its position in response to the public outcry, and has affirmed that it will continue protective measures at selected sites. At the same time, it has emphasized that at some point in the future all national seashores will be left to the natural alterations of normal coastal processes.

In the National Park Service publication (1973) entitled "A Strategy for Management of Marine and Lake Systems within the National Park System," the economic implications of the policy are discussed:

"The Army Corps of Engineers. . .concluded that 2,700 miles of shoreline in the United States are undergoing 'critical erosion.' Remedial measures would cost \$700,000 per mile, with an annual maintenance of \$30,000 per mile. The total cost would be \$1,800,000,000, with an annual maintenance cost of \$73,000,000."

The remote sensing services of the Chesapeake Bay Ecological Program Center of the NASA Wallops Flight Center played an important part in the policy change which will represent financial savings amounting to tens of millions of dollars.

According to Dr. Hayden, the NPS decision is having an influence on other coastal managers. A county on Long Island, New York, has announced that it will imitate the management policy developed by the NPS.

In discussing alternatives to Wallops' cooperation, Hayden comments that it would be too costly to fly coastline missions from Houston or other NASA bases. In special circumstances, Hayden conceives that NPS might hire private remote sensing firms.

Hayden says he has visited NASA Wallops several times to locate the proper imagery for his research, and on these occasions has always been granted the full use of NASA's facilities. He mentions specifically the use of instruments

U. of Va., Dept. of Environmental Sciences cont'd.

like the densitometer. He also expresses appreciation for the tours and IARS training courses that Wallops has provided to classes visiting from the University of Virginia, even accommodating the students with lodging at the Flight Center.

In discussing the monetary impact of remote sensing, Hayden says that because of the high cost of alternative methods, there would have been no studies of the present nature without remote sensing. Different kinds of studies would have had to be done.

Hayden does not think that NASA's programs are in conflict with those of scientists. On the contrary, he believes that NASA remote sensing has promoted scientific advancement.

When asked by the interviewer to offer recommendations for improving Wallops' services to remote sensing users, Hayden said that it would be valuable if he and other users could know the Wallops flight schedule. He suggests that synopses of past and future flights could be circulated in a format similar to a newsletter.

In commenting on new sensors and equipment, Hayden says that he had expected "great things" from densitometry but "it hasn't panned out for us."

Hayden says that he and his co-workers have "always had good cooperation with Wallops." He realizes that he and other users have often been remiss in failing to acknowledge the credit that is due NASA, but he expresses his resolve to make amends in the future.

Dr. Hayden says, "NASA is one of the few providers in the whole world of archival information. NASA is almost unique as an impartial acquirer of information."

UNIVERSITY AND COLLEGE cont'd.

University of Virginia, Department of Environmental Sciences--
Dr. John Fisher.

Dr. John Fisher is an assistant professor in the Department of Environmental Sciences. Although educated as a civil engineer, he now pursues a career in coastal hydrodynamics. He has engaged in a number of research studies of the Atlantic coast and barrier islands for the National Park Service.

Assessment of Beach Nourishment Projects at Cape Hatteras: As the principal investigator of a study on Cape Hatteras for the Atlanta region of the National Park Service, Dr. Fisher used imagery acquired by NASA Wallops to monitor the accretion and loss of material at sites of beach nourishment projects. Especially important to the investigation was the acquisition of imagery taken in all seasons of the year.

Monitoring Effects of Major Storms on Mid-Atlantic Coasts: Another instance of the utilization of Wallops' remote sensing services on studies under Dr. Fisher's supervision is the continuing surveillance of the effects of major storms on the mid-Atlantic coasts from New York to the Carolinas, with particular emphasis on Assateague Island.

The NPS studies in which Dr. Fisher has been involved have utilized imagery taken by Landsat, the multi-channel scanner of NASA Houston aircraft and the aircraft of NASA Wallops.

Fisher told the interviewer that the data recovered in his studies are used by other coastal investigators. The data are shared with the Virginia Institute of Marine Science and the Underseas Research Division of the Westinghouse Corporation. Fisher has also furnished data to satisfy requests for information about Cape Hatteras by the U. S. Corps of Engineers (Baltimore office)

U. of Va., Dept. of Environmental Sciences cont'd.

and about Assateague Island by the Maryland Geological Survey.

Fisher says that the data resulting from studies using the remote sensing services of NASA Wallops will find their way into the hands of other users after they are printed in the publications of the academic community.

In the study of storm effects, it would be profitable if the researchers could observe the actions of storms in progress. To achieve this end, Dr. Fisher has been consulting with Gil Trafford of NASA Wallops to develop ways to image the situation by radar.

As a shortcoming of the services of NASA Wallops, Fisher lamented the fact that missions cannot always be flown at the time they are needed most. Fisher attributes this defect to the insufficiency of the NASA budget.

The future studies of the University's Department of Environmental Sciences are expected to use the remote sensing services of the Chesapeake Bay Ecological Program in connection with the renewal of the University's contract with NASA, with contracts in basic research funded by the United States Army, and with other unnamed contracts which are anticipated.

When asked how many people are affected by the results of his studies, Fisher replied that 2,000,000 people visit Assateague Island and 1,000,000 visit Cape Hatteras each year.

Dr. Fisher is optimistic about the prospects for obtaining new kinds of data by use of multi-spectral scanners. He is equally sanguine about the potential of laser-profiling.

Speaking about the development of new sensors. Fisher says, "We don't need new inventions. We are told that the Military has for years been using equipment which is far superior to that available to us civilians. We'd be happy if we could just get that instrumentation declassified."

U. of Va., Dept. of Environmental Sciences cont'd.

Dr. Fisher says, "The cooperation and advice of Paul Alfonsi and the staff at Wallops Flight Center have been a tremendous advantage to my studies. There is no question of Wallops' importance.

"I know that Wallops is not receiving feedback from its users. I'm sorry about the situation. Maybe Wallops should demand feedback. It would be a shame for a resource like NASA Wallops to dry up. Maybe more formal arrangements are needed."

When the interviewer solicited an overview of Wallops' contributions, Dr. Fisher said, "From the standpoint of Science, NASA has a damned good reason for being."

UNIVERSITY AND COLLEGE cont'd.

University of Virginia, Department of Environmental Sciences--Jeffrey Heywood.

Jeffrey Heywood is a faculty member of the Department of Environmental Sciences. He has participated as a scientist in research studies for the National Park Service at the Cape Hatteras and Assateague National Seashores.

Heywood says that the coastal studies for the NPS require greater quantities of photography than most studies. This is because of the linearity of the study areas. NASA flight patterns are very well suited for acquiring the type of photography needed in seashore research.

Imagery Used for Ground Truth Operations: In addition to using NASA Wallops imagery in the expected way, Heywood and his co-researchers also found the photographs useful at Assateague Island to locate themselves in the field during ground truth operations. The party members were able to determine their ground positions by correlating the physical features of sand dunes, vegetated sand flats, vegetative stands, etc., to photographic details differentiated by hue and texture.

Heywood believes that the United States Geological Survey may want to use the imagery and data of the University's coastal research for the agency's study of the central Atlantic area.

Imagery Used for Classroom Instruction: Heywood told the interviewer that the NASA imagery obtained by the University for its NPS studies often receives secondary "in-house" usage, meaning that the material is used for classroom instruction and student projects. Heywood noted that the landscape architecture curriculum has an especially close connection with remote sensing.

Remote Sensing Instruction at the Flight Center: Heywood teaches a

U. of Va., Dept. of Environmental Sciences cont'd.

mini-course called Introduction to Remote Sensing for graduate students in landscape architecture. In December, 1974, Heywood's class visited the NASA Wallops Flight Center to study the remote sensing operations of the Chesapeake Bay Ecological Program. Dr. Harold Maurer lectured to the students about the LARS computer program.

Heywood's past studies have not required the use of specialized equipment at the Wallops Flight Center, but he feels that the situation may change when the University resumes work under the recently renewed Landsat contract. Heywood and his co-researchers avail themselves of lodging accommodations at Wallops when visiting the Flight Center. Heywood frequently confers with Wallops' Mike Conger for guidance and advice.

In enumerating the various sources of aerial photography available for making historical comparisons of coastlines, Heywood mentioned the National Oceanographic and Atmospheric Administration. He says that NASA has a library of relevant photography which is an important alternate choice to NASA photography.

Heywood prefers a matte (non-gloss) finish on the photography he uses. A scale of 1:10,000 is best for his purposes, but the University owns a magnifying instrument which can compensate adequately for other scales.

In a letter to Paul Alfonsi, Director of the Chesapeake Bay Ecological Program, Heywood described the value of NASA Wallops' contribution to the NPS coastal research studies:

"Your staff introduced us to equipment and techniques for imagery analysis of which we had been unaware. As a result, we foresee expanded avenues of approach to our research problems and a higher degree of accuracy in data acquisition through the use of such equipment as the I²S machine and the densitometer."

U. of Va., Dept. of Environmental Sciences cont'd.

Heywood says that the resolution of the Wallops imagery is "good" and the coverage "excellent."

Heywood has found the Remote Sensing Handbook issued by the Chesapeake Bay Ecological Program Office to be very helpful to his research and teaching.

Heywood says, "Wallops has given us fantastic cooperation and their tours are getting better all the time."

In complying with the interviewer's invitation to express his thoughts about deficiencies of the Wallops imagery, Heywood said that some of the color infrared film is dark around the edges, making interpretation difficult. However, stereo-viewing improves the situation and, furthermore, reduces eye-strain. Heywood says that his studies normally require less than the ultimate in discrimination.

In commenting on the role that NASA Wallops plays in remote sensing instruction at colleges and universities, Heywood expresses his belief that training course at Wallops would be highly valuable to an academic curriculum. The course would be especially useful for instructing students in NASA methodology and suggesting avenues for present and future research activities. Furthermore, the training course could acquaint the students with instruments and equipment which academic institutions cannot afford to own.

Heywood feels that an Introductory Course to Remote Sensing sponsored by NASA Wallops would be effective even if scheduled for a period as short as two days. Moreover, a course of a week's length would prepare an attendee to become an active user of NASA's remote sensing services.

Heywood's opinion is that the existence of NASA's remote sensing program is not well-enough known. He says, "NASA should spend some effort getting the word around. Many people I have talked to don't know the service is available. New users aren't being encouraged. Publicity is needed."

U. of Va., Dept. of Environmental Sciences cont'd.

Heywood's conviction is that it would be improper for NASA to make its remote sensing services available to private interests.

The University of Virginia schedules no classes in remote sensing per se. The only related class is called Environmental Photography and is taught in the School of Agriculture. The course touches on remote sensing only lightly. Heywood thinks the University definitely needs classes in remote sensing and he hopes the deficiency will soon be amended.

UNIVERSITY AND COLLEGE cont'd.

University of Virginia, Department of Environmental Sciences--
Dr. Robert Dolan.

Dr. Robert Dolan is a member of the faculty of the Department of Environmental Sciences. He returned to the University in August, 1975, after a year's leave of absence in London where he was on assignment for the U. S. Office of Naval Research.

Dr. Dolan has achieved prominence in his field for a number of important studies in the investigation of coastal processes. He has served as contractor and consultant to the National Park Service for many years.

His studies have embraced the subjects of shoreline morphology, coastal erosion, dune stabilization and beach nourishment. The results of his research at Cape Hatteras National Seashore have been directly responsible for the National Park Service's major policy decision to discontinue beach protection projects.

In Dolan's absence, studies of National Seashores for the National Park Service continued under the direction of other University of Virginia faculty members.

Highlights of an interview with Dr. Dolan:

"I have been thinking about the role of the Wallops program in the remote sensing expertise of the Virginia-North Carolina area. Wallops hasn't been getting full credit for the scope of its contributions to the ecological management of the region. Too often, acknowledgments have consisted of little more than a line or two at the end of a written report, telling that NASA provided photography for the study. That isn't enough. There has to be some better system for users to report the value of the various ways that the Wallops remote sensing program contributed to their projects.

U. of Va., Dept. of Environmental Sciences cont'd.

"The Chesapeake Bay Ecological Program, like other NASA aircraft programs, is being criticized by the higher-ups. Headquarters is contemptuously calling the remote sensing programs 'suppliers of imagery.' Maybe we users are to blame. We should be doing a better job at making everyone understand what remote sensing has meant to our projects. Too often it's been a one-way street. We've accepted NASA's services, but we have given nothing more than our 'thanks' in return. There's a lot more to Wallops' (remote sensing) services than the mere distribution of aerial photography. If that's all there is to it, then NASA should redefine the program.

"I propose that each user of the remote sensing services be asked to prepare a detailed, written report at the conclusion of his project. The report should clearly describe all the ways that NASA's remote sensing program helped the project.

"If it's true that NASA is only a supplier of photography, then NASA should go back and redevelop the program. But Wallops did a lot more for us than merely supply imagery. We had a series of coastal problems that had to be solved. We first went to Wallops for help about six or seven years ago. We sat down and described our problems to Paul Alfonsi. Paul, in turn, called in the NASA staff. The staff listened to us and then made recommendations on how we should proceed to recover the data we wanted.

"It is well known that at present there is less money available than formerly for government programs--the NASA programs included. A certain amount of NASA dollars is allocated to the experimental programs, and, among these, the Chesapeake Bay Ecological Program probably doesn't have a high priority.

"The Ecological Program apparently doesn't have strong documentation to support its case. It is not an aircraft-support operation--at least not like

U. of Va., Dept. of Environmental Sciences cont'd.

Houston, Goddard, etc. It has to seek its money in competition with these other bases--and they have a higher ranking.

"The Wallops remote sensing program just doesn't have enough work. NASA doesn't want a small program like Wallops'.

"The Program wants--it needs--stronger documentation. It needs to be able to convince the higher-ups that it is more than the simple dispensing of aircraft photography. And it is more than that. True, providing imagery is part of the Wallops program, but it's only one facet of the program.

"When we, as contract scientists for the National Park Service, went down to Wallops to find out if remote sensing could do anything for us, we didn't even know what remote sensing was all about. We frankly told the Wallops staff we didn't know how to process information or how to interpret imagery.

"We didn't even know how to set about the task. We had to ask the Wallops staff, 'How can we get these data into a form we can analyze?' Then they showed us how. We worked right on the Wallops base for weeks, while the staff taught us the methodology of remote sensing. Wallops was responsible for building up our expertise in remote sensing.

"I suggest that if documentation is needed, the Chesapeake Bay Ecological Program should use its 'leverage' to obtain stronger statements about all the ways in which the Wallops program contributed to the projects. I have offered to write a discussion paper--a memo--containing the whole history of my use of remote sensing.

"One of the graduate students of Paul Godfrey (Assistant Professor, Department of Botany, University of Massachusetts), who is using Wallops' services for a study of the Virginia barrier islands, has consented to write a paper about her experiences using remote sensing. The paper will be submitted to the people at Wallops.

U. of Va., Dept. of Environmental Sciences cont'd.

"There's a world of difference between a footnote at the bottom of an article and a paper with a full description of remote sensing's use woven right into the paper's design. That's the kind of paper Godfrey's student is going to do.

"Too many of the users of Wallops' services have only shown their gratitude to NASA with a few lines of credit at the end of a study paper. I'm guilty too. That's the way of us academicians, I'm afraid. We concentrate our interests on our own work, and we neglect to acknowledge the help we've received from others.

"Yes, I just spent a year in Europe. I got back less than two weeks ago. I was on leave from the University (of Virginia) to work for the Office of Naval Research. I was stationed in London as a liaison scientist. My assignment was to observe the work that European scientists are doing in coastal processes research. No, the Europeans are not ahead of us. In fact, they're about five years behind.

"I am trained as a geologist. No, I'm not Chairman of the Department of Environmental Sciences. I gave up that position about five years ago. I don't want it back, I was glad to get rid of it.

"I don't think that NASA has reached the point where they'll get out of remote sensing. The nation's economy would have to go into a real tailspin before that would happen. The investigations of the other planets, the moon and the earth's atmosphere are vigorous programs. The study of earth resources is a major mission. Surveillance for (military) intelligence purposes is giving momentum to remote sensing. The impact of remote sensing is increasing all the time. Now remote sensing is even being used in day-to-day projects.

"There was a time when research projects found it necessary to go out and bring in a specialist to do the remote sensing phases of the study. It's not

U. of Va., Dept. of Environmental Sciences cont'd.

that way anymore. Now we have many people with remote sensing expertise. And it's all because of NASA's remote sensing programs. Here at the University, it used to be that no more than two people out of 27 would have remote sensing experience. Now, there would be 20 or more who would have had experience with remote sensing.

"Is remote sensing cost-effective? That's a good question. Perhaps it hasn't been in every case in the past. But it will be in the time to come. The users of remote sensing in the future will know intuitively that remote sensing has a cost-benefit.

"When NASA discontinues its cooperative remote sensing programs, the users will certainly turn to private remote sensing firms. At that point, they'll be so used to using remote sensing that they won't be able to do without it. These various agencies and present users of remote sensing would certainly spend the money. There's no question that the National Park Service would spend money for remote sensing.

"Europe also is doing remote sensing. They're using their own aircraft for remote sensing and they're using America's Landsat. All over Europe and throughout the world, the other countries are buying imagery from NASA. Even Russia buys imagery from NASA."

UNIVERSITY AND COLLEGE cont'd.

Center for Environmental and Estuarine Studies, Chesapeake Biological Laboratory, University of Maryland--Charles Rawls and Klaus Drobeck.

Inventory of Coastal Zone Borrow Pits from Cape May to Cape Charles: At the instigation of the U. S. Fish and Wildlife Service, the Water Resources Administration of the Maryland Department of Natural Resources, and perhaps other agencies, Charles Rawls of the University of Maryland, Center for Environmental and Estuarine Studies (at that time the Natural Resources Institute), was assigned to carry out an investigation of borrow pits along Atlantic coastal areas. Rawls interpreted his assignment as including on-shore and off-shore excavations. Furthermore, he considered the broad definition of "borrow pits" to include various types of excavations as channel dredging sites, marinas, mosquito ditches, laterals, etc.

The proposition by the USFWS and WRA to conduct a borrow pit survey received enthusiastic support from the Director of the Natural Resources Institute, and it was adopted on the agenda of the Institute's research.

Originally, Rawl's study comprised several objectives: (1) to locate and chart the borrow pits; (2) to discover their origin; (3) to record temporal changes in the pits; (4) to determine the pits' effects on flora and fauna; and (5) to derive a value judgment about whether, in general, borrow pits are beneficial or detrimental.

The study was never carried through in its entirety. Rawls did locate and chart the borrow pits as he set out to do. In most cases he was able to learn the origin of the pits. In addition to inventorying the pits, Rawls endeavored to classify the pits, whenever possible, as to size, age, slope-gradient, location (on-shore or off-shore) and purpose. The study never received the

UMCEES, CBL cont'd.

funding necessary for examining the biological effects of dredging or for monitoring evolutionary changes. Understandably, no value judgments about borrow pits were attempted.

The primary objective of Rawl's study was the inventorying of all borrow pits situated along the Atlantic coast from Cape May at the mouth of the Delaware Bay to Cape Charles at the mouth of the Chesapeake Bay. He searched the headwaters and tributaries of the bays. To locate the excavations, he utilized the services made available to him at the National Aeronautics and Space Administration's Wallops, Virginia, installation.

NASA's index was used to determine which flights were useful and the dates of the flights. The imagery desired was readily accessible through the data-retrieval system. Infrared and natural color were scrutinized. For the purpose of his study, Rawls found that imagery taken at moderate altitudes (10,000 feet) was superior to imagery taken at high altitudes (60,000 feet).

Rawls expressed satisfaction with the generous and courteous cooperation he received from the NASA Wallops personnel. The imagery furnished in full measure the information he required. Only one feature of the imagery proved troublesome: the cloud shadows which resembled borrow pits.

Testimony to the value of Rawls' work is the appearance of his borrow pits on the new topographical maps which the United States Geological Survey issued in 1973. The excavations are accompanied on the maps with a notation as to type. Presumably, these kinds of information did not appear on previous maps. The maps should continue to be of the greatest importance for many years.

Even though the success of the study was generally recognized, no financing for the completion of the investigation was forthcoming. The remaining objectives of the study were not researched. Since the conclusion of the study, Rawls has returned to other fields of investigation.

Rawls' study was important for three reasons: (1) his inventory of borrow pits (with classification) was incorporated into the 1973 U. S. Geological Survey topographical maps; (2) his study was the basis for a subsequent study of importance by Klaus Drobeck of the Natural Resources Institute; (3) his study was a much-requested subject at seminars and conferences.

Assateague Ecological Studies: Klaus Drobeck of the Center for Environmental and Estuarine Studies (formerly the Natural Resources Institute) described a study he had done which indirectly involved NASA imagery. His study was a single phase of a larger study financed by the National Park Service: a broad-scale assessment of all aspects of Assateague Island in anticipation of the conversion of the entire island into a national park. Transects were made of three borrow pits lying in bays behind Maryland's barrier islands. The purpose was to record the distribution of animal life within and outside the pits. Drobeck used the information garnered by the Rawls' borrow-pit inventory to locate and determine the boundaries of the pits for his own study. The objects of his study were: (1) a pit near the Isle of Wight in Assawoman Bay, excavated in 1962; (2) a pit in Sinepuxent Bay south of Ocean City, excavated during construction of a bridge across Assateague in the 1960's; (3) a pit in Chincoteague Bay, excavated during construction of a power line between Chincoteague and Assateague in the late 1950's.

The results of Drobeck's study are contained in a report published by the Natural Resources Institute of the University of Maryland, Contribution Number 446. The report is called Assateague Ecological Studies. Drobeck's work appears in the Benthos section. The conclusions of the Drobeck study can be summarized briefly:

UMCEES, CBL cont'd.

The distribution of animal life in and around borrow pits excavated in shallow waters near shore differs markedly from the distribution in the unmodified surrounding areas. The additional depth, the accumulation of mud, clay and vegetable detritus and the turbidity created during dredging operations result in a severe diminution of the animal population. Deepwater borrow pits represent a less serious threat to the animal life, chiefly because the animals are less abundant anyway and because larger and more mobile species are involved. Nevertheless, Drobeck recorded a deficit in the animal population of deepwater pits. The fact that Drobeck's study was used in several litigations is an indication of its importance. The research was not continued because of insufficient funds.

COUNTY ORGANIZATIONS

Chester County (Pennsylvania) Board of Health--Benjamin Reynolds.

Benjamin Reynolds is a non-professional member of the Chester County (Pennsylvania) Board of Health. He calls himself "retired," though, in fact, he is still very active. According to Paul Alfonsi (NASA Wallops), Reynolds is a wealthy entrepreneur and the developer of a model city.

This interview involves the use of Imagery from NASA Wallops in the Interest of the Public Health. It is a case which can be documented in detail and represents the use of Wallops remote sensing imagery for the highest of purposes: protecting the health and lives of the citizens.

The Brandywine River flows southeasterly through the extreme southeastern section of Pennsylvania and crosses the Mason-Dixon Line into Delaware. It empties into the Delaware River at Wilmington. The main branch of the Brandywine is about 20 miles long (according to Mr. Reynolds). The river passes through a highly urbanized district and its quality has been the object of long and close scrutiny. Mr. Reynolds says that the Brandywine has been studied to the "nth degree." Those who monitor and safeguard the river are justifiably proud of the results of their work.

The Brandywine River is the raw water supply for the city of Wilmington, Delaware, and part of its environs. As such, the river affects the lives of more than 250,000 people. The quality of the Brandywine's water is jointly monitored by the Chester County Board of Health, the Chester County Water Resources Authority, the Commonwealth of Pennsylvania and the United States Geological Survey of the United States Department of the Interior.

In the summer of 1973, a water quality problem of grave proportions suddenly erupted. The fecal coli count skyrocketed from less than 100 to

CCBH cont'd.

60,000 parts per million. Attempts to locate the source of the contamination were confounded by the fact that the pollution occurred on an intermittent basis.

A general alarm was raised. The agencies and departments involved in the monitoring of the Brandywine bent every effort to stem the threat to the health of more than a quarter-million people. Cooperative investigative programs among the various groups were carried on under the code names of Aquarius I and Aquarius II.

Despite untold man-hours (with the attendant costs) devoted to the investigation, no progress was made. None of the normal parameters could present a solution. The authorities resorted to novel procedures in their desperation. The Chester County Department of Health carried out tests on the stream's specific conductance. The U. S. Geological Survey lent a drogue in the shape of a "metal fish" for recovering sub-surface samples of the water.

Ill-feeling arose between the states of Pennsylvania and Delaware. The Chester County Health Department was confronted by the prospect of multiple legal suits.

Benjamin Reynolds, member of the Chester County Board of Health, was forced to conclude that, despite exhaustive efforts, "we had pulled a blank." Reynolds determined as a last resort to turn to the techniques of remote sensing to probe the enigma. An omnivorous reader, Reynolds had developed an admiration for the capabilities of remote sensing as described in the many publications he had read.

Reynolds made the decision to call on the National Aeronautics and Space Administration for help. He would ask them "to bring in their heavy hardware." Reynolds by then had become convinced that the source of the fecal contamination

CCBH cont'd.

was an unknown pipe that was disgorging its contents at some depth invisible to surface observers. He reasoned that the pipe could be located by heat-recording methods which could detect the differences in temperature between the sewage plume and the rest of the stream.

Reynolds placed a telephone call to Paul Alfonsi, Director of the Chesapeake Bay Ecological Program at the NASA Wallops Flight Center. Alfonsi immediately offered the participation of NASA's resources to attack the problem. After consultation with Reynolds, Alfonsi and perhaps other Wallops personnel scheduled aerial flights over the Brandywine River.

Adverse weather prevented immediate flights, but within several days Wallops dispatched a Bell U. S. 1H helicopter and a Douglas C-54 fixed-wing aircraft to record the river by infrared photography.

For the interpretation of the infrared film, Alfonsi dispatched the Wallops Ground Truth Van to Chester County. The local authorities and NASA personnel examined the imagery at the van's light table. The film was successful in pin-pointing the source of the pollution.

The solution lay in the series of tire tracks that stressed the vegetation in a riverside field at some remote and almost inaccessible sector of the Brandywine. The frames of infrared imagery revealed the tracks in vivid contrast.

To the local authorities who had worked on the case, the tire tracks were the key to the mystery. The tracks wound through the field grown high with 4-7 foot weeds and ended at the riverbank. It was promptly recognized as an illegal and clandestine dumping operation. The inference was clear: some septic tank cleaning contractor was taking advantage of darkness and the remoteness of the site to unload the contents of his truck. Except for the intermittent schedule of the dumping, the culprit would have been detected in short order.

CCBH cont'd.

The Chester County Department of Health notified the Pennsylvania State Police and instructed them to post marked patrol cars in the vicinity of the dumping. With the fate of so many people at stake, the authorities were taking no chances; the capture of the culprit was subordinate to the immediate abatement of the hazard.

The posting of the marked patrol cars worked. No more illicit dumping took place. The coliform count dropped dramatically--from 60,000 to 100. Relations between the city of Wilmington and Chester County became cordial again. The animosity between the states subsided.

A Wilmington newspaper printed a feature story about the episode and praised the Chester County Health Department for its success in tracking down and terminating the contamination. A public meeting was held at which the head of the Wilmington Water Department, A. J. Maitland, expressed his appreciation and gratitude for the efforts of the Chester County Health Department.

The contamination in the Brandywine never recurred. Today it is a model river. Its waters are as pure as any in the urban east. Anglers find that fishing is good farther upstream than ever before.

Mr. Reynolds and the other members of the Chester County Health Department are effusive in their praise of NASA Wallops and Mr. Alfonsi.

COUNTY ORGANIZATIONS cont'd.

Accomack - Northampton Planning District Commission (ANPDC)--
Dr. George V. Podelco.

Accomack and Northampton Counties comprise Virginia's Eastern Shore, a narrow peninsula lying between the Atlantic Ocean and the Chesapeake Bay. The region was first explored by Captain John Smith in 1608 and settled a half-dozen years later. In 1970, the combined populations were less than 45,000. The combined land area totals about 700 square miles.

The rich soil of the counties supports a productive agricultural industry. Many local residents earn their living through the harvest of the oysters, clams and finfish which inhabit the bays and inlets of the peninsula. The counties employ a considerable number of citizens in the processing and packing of vegetable, fruit and seafood products. The temperature, climate, extensive shore line and favorable location along a major north-south traffic artery sustain a vacation and tourist trade which is important to the peninsula's economy.

Accomack and Northampton Counties constitute Virginia Planning District 22. Dr. George V. Podelco is the Executive Director of the District 22 Planning Commission, with offices in the small community of Accomack.

Dr. Podelco has been a frequent user of the remote sensing services of the Chesapeake Bay Ecological Program at NASA Wallops. He estimates that during the last two years he has made six or eight visits to Wallops to examine the aerial photographs on file and to use the light tables. He used the imagery for a variety of purposes connected with his planning duties.

Podelco has used the Wallops imagery for Wetlands Observations and for Inventorying and Measuring the Peninsula's Ponds. He says that the imagery

ANPDC cont'd.

has given him a knowledge of the Peninsula's Water Resources, and has made the Alluvial Patterns of Erosion more visible than from the ground. Podelco states, "NASA imagery gave me a true appreciation of the Extent and Effects of Erosion Caused by Large-Scale Developments."

Dr. Podelco periodically checked the progress of Pine Bark Beetle Damage at intervals during the period when the beetle attack was epidemic on the Virginia Eastern Shore. He has assessed Storm Destruction by comparing contemporary imagery with old photographs. He finds that the accumulation of imagery provides an opportunity to observe temporal changes which are invaluable to a planner. He has utilized the imagery to Establish Trends in Land Use.

Podelco plans to consult the imagery in efforts to trace the Water Run-Off from Chicken and Food Processing Plants and to discover Sewage Drainage Patterns which are now unknown. The drainage of pollutants into the offshore waters has caused the Virginia Bureau of Shellfish Sanitation (under Director Cloyd Wiley of Richmond) to condemn a number of areas and to prohibit the harvesting of the fishlife for food purposes. The Bureau's rulings have had an adverse impact upon the economy of the fishing and sea-food packing industries of the Eastern Shore. For verification, Podelco invited the interviewer to confer with Leonard Burton of Chincoteague, Virginia, who owns a shellfish processing company and who is reputed to be the world's number one purveyor of clams.

Dr. Podelco states that the Wallops color infrared imagery is excellent for providing background information about issues and problems he is involved with. He says that color infrared conveys an optical definition which is almost stereoscopic or three-dimensional in effect. He signifies the outstanding utility to him of a connected series of 12" x 12" photos which depict the

ANPDC cont'd.

length of the Virginia Eastern Shore from the Maryland border to the Chesapeake Bay Bridge-Tunnel.

Wallops has offered Podelco copies of pertinent imagery for use at his office, but he has had to decline the offer because he lacks a light table. Podelco considers the imagery to be invaluable for studying beach erosion and most any other environmental situation.

Podelco's use of the services of the Chesapeake Bay Ecological Program Office is in connection with the duties of his position. He assists the counties of Northampton and Accomack in the formulation of ordinances and codes. He has helped the peninsula's five largest communities to create zoning regulations and sub-division ordinances. He makes recommendations on soil erosion and sedimentation to county officials drafting control ordinances, and he is preparing a handbook to accompany his recommendations. He is helping to write a Comprehensive Land Use Plan for Northampton County.

Podelco has frequently solicited the aid and advice of Paul Alfonsi and Gil Trafford at NASA Wallops. He and his close associate, Dr. Albert Viczian, Senior Planner of the Accomack-Northampton Planning District Commission, are eager to enroll in the Wallops IARS course. Twice the men have made preparations to take the training but have been frustrated by last-minute changes in their schedules.

When the interviewer asked him what he would have done if Wallops data had not been available, Podelco said he would have "done without." He said that aerial photographs of the peninsula by the Soil Conservation Service are too old for his purposes, and that on-site inspections require expensive equipment beyond his budget. Time, distance and authorization are also deterrent factors, as is the requisite manpower.

Podelco's words manifest a respect and admiration for the Wallops remote sensing operations and an easy rapport with the NASA personnel.

PRIVATE ORGANIZATIONS

The Delmarva Pine Bark Beetle Council—Rudolph Baliko, Forestry Consultant.

Rudolph (Rudy) Baliko is a self-employed forestry consultant whose knowledge and advice are solicited by lumber firms and tree farm owners. His office is in his home and here he keeps his records and equipment, such as a light table for scrutinizing imagery and aerial photography.

Baliko believes that the pine bark beetle has always been a problem to the Delmarva pine forests. Records show that beetle populations peaked in the late 1940's and again in the late 1950's, although the damage was not so extensive as in the instance which will be described in the coming pages. Baliko says that the pine bark beetle is the number-one enemy of the Delmarva pine forests.

In the late 1960's and the first two years of the 1970's, the Delmarva Peninsula suffered a prolonged drought. Baliko's figures taken from weather stations on Maryland's Eastern Shore show that the affected counties received less than half, sometimes only a quarter, of the average annual rainfall. This condition diminished the vigor of the pine trees and rendered them susceptible to insect attack. Baliko says that the soil types were also a factor because their compositions allowed very little moisture movement (i.e., the soils absorbed and stored little moisture).

The beetle attack occurred in pine stands all over Delmarva. The attack was very conspicuous. Depredations by the pine bark beetle were known previously, but this time the damage was more extensive than ever before.

The foresters and lumbermen were first aware of the seriousness of the attack, but it soon reached the attention of the public, the newspapers and

DPBBC cont'd.

elected politicians. The public was "very concerned." The situation was serious enough that the elected officials petitioned the federal government to declare the Peninsula "a disaster area." Federal authorities, however, refused to grant aid on the grounds that the affected citizens had not suffered direct and immediate loss.

The forestry departments of Virginia, Maryland and Delaware conferred frequently about the enlarging infestation. At length, they brought together representatives of the lumber industry, processors and woodlot owners in the fall of 1970. These parties founded the Delmarva Pine Bark Beetle Council at that time. The forestry departments of the three states sat in on the meetings of the Council. The U. S. Forest Service was also involved.

The Council hired forestry consultant Baliko as the Executive Director. Baliko's function was "to coordinate activities of the three state forestry departments, the U. S. Forest Service and the industry in combatting and alleviating problems caused by the pine beetle infestation."

Blaiko quantified the severity of the infestation like this: Entomologists consider beetle infestation to be epidemic if 100 beetles emerge from a tree in a one-square foot area. In Delmarva, the beetles were emerging at a rate of 400 insects per square foot!! This fact is even more alarming when one considers that the beetle population has four or five generations a year in Delmarva.

The beetle has a secondary effect on pine lumber. The insect is the vector of the blue stain fungus. The insect transmits this fungus, which in itself can kill a tree, or at least degrade the timber. The fungus weakens the fibers, reducing the strength of the wood and thus its value. The blue stain imparted to the lumber would automatically relegate the product to an undesirable status.

Baliko was not associated with the Council's work until after its inception. He believes that NASA Wallops became involved when a NASA employee attended a meeting where he heard the beetle problem described. The NASA man proposed that remote sensing offered the best-suited tool for assessing the problem. The association between the Council and Wallops began after this. Wallops was only then developing its remote sensing program and welcomed the opportunity for researching and developing techniques.

Campaign against the Delmarva Pine Bark Beetle Epidemic: NASA Wallops flew a series of flights, perhaps as many as 20, in 1971 and 1972 (as Baliko remembers). The Wallops flights were flown by C-54's at 10,000 feet. NASA Houston flew a single C-130 mission at medium altitude. Black-and-white infrared and color infrared photographs were taken. Baliko says the color infrared provided the desired results. It imaged the areas of infestation, revealed the degree of infestation, delineated the extent and even showed the routes by which the work crews could gain access. Baliko says that conventional aerial photography could not have detected the stressed pine trees as well as color infrared. Baliko also says that Wallops color infrared was "completely" equal to its task.

The Wallops imagery showed color changes in the crowns of the pine trees, and, more importantly, alterations over an extended period of time.

In speaking about the early detection of beetle attack, Baliko says that the first signal is the appearance of pitch tubes on tree trunks. The tubes occur when the pine tree reacts to the tunnel-drilling by the boring beetles. Several other species of beetles attack pine trees in the same way, but the southern pine bark beetle is Enemy Number One.

Aerial photography and infrared imaging are not able to discover infestation until the trees' deterioration has progressed to a serious degree. Infrared

DPBBC cont'd.

is much more efficient at detecting color changes in the infested pine-crowns than is conventional film. However, Baliko says that even by the time the infrared cameras spot the damage, the tree is already essentially dead. Baliko, of course, would rejoice if techniques could be developed to detect pine bark beetle infestation at the pre-visual stage.

The Delmarva pine forests suffered extensive damage. Baliko says that 120,000,000 board feet of timber was killed. One-half of this was salvaged, 50,000,000 to 60,000,000 board feet. The remainder was left standing to rot away. Baliko estimates the value of the affected timber at \$5,000,000 to \$6,000,000.

Baliko amplified on the salvage-cutting operations which followed the deterioration of the badly infested areas. Many of these areas could not be harvested because of excess ground water. It seems that after the protracted drought which had stressed Delmarva's pines to the point where beetle attack became epidemic that the Peninsula was visited by several years of heavy precipitation. The timber-transporting equipment owned by the Delmarva operators was predominantly of a rubber-tired type which was poorly suited to working in saturated-ground conditions. For this reason, at least half of the infested trees were left to rot.

Baliko at that time recommended that the operators begin replacing their rubber-tired vehicles with vehicles using the endless-track system with which bulldozers are equipped. The capability of the endless-track vehicles to operate successfully in very wet areas has been proven elsewhere in the country.

Also, according to Baliko, the market for pine timber was at low ebb during the time of the beetle infestation in Delmarva. The proper course of action would have been to cut and store the infested timber. However, under

DPBBC cont'd.

the standard practice of storing timber, the destruction of the wood by the beetles would have continued during storage. A proposal was made by professional foresters, notably by Jack Brodie of the Maryland Forest Service, to store the timber in piles that were subjected continuously to water-sprinkler systems. The rationale was that the timber would absorb the water and drown the beetles ensconced in the cambium layers. Brodie envisioned a huge storage yard where 20,000,000 board feet of timber could be held and treated. This proposal was never carried out, but the Maryland Forest Service is conducting experiments with a much smaller sprinkler-storage yard at the present time.

Baliko remained as consultant to the Council for eight months. The Council still exists but isn't active because subsequent years have brought normal precipitation to Delmarva and the pines have grown vigorous again. The pine bark beetle population is now quiescent, but Baliko thinks that beetle infestation will recur sometime in the future.

After areas of greatest infestation were identified by use of Wallops imagery, Baliko contacted the forestry departments of the three states. The Virginia Division of Forestry used airplanes to check on Baliko's discoveries. Baliko also reported his findings regularly to the Northeast Region (of which Maryland is a part) and the Southeast Region (of which Virginia is a part) of the U. S. Forest Service.

He also notified the timber owners of the three states. The owners' course of action was to harvest immediately before the damaged trees deteriorated. Nevertheless, about half of the infested trees were lost. Baliko says the worst infestation of all occurred in Accomack County, Virginia, and Worcester County, Maryland. Wallops imagery was requested for only the worst areas of infestation.

Baliko says that during the infestation of the early 1970's, the beetle caused more damage than the cumulative damage of all the forest fires that Delmarva had experienced since 1940.

When asked how many persons in the pine logging and processing industry were affected by the pine bark beetle damage, Baliko promptly tallied from data in his files the number employed in the Maryland section of Delmarva: 878 persons. A rough estimate of the number of persons involved in Virginia and Delaware could be reckoned from the Maryland figure.

Baliko says that lumbering is a "vitally important industry of the Maryland Eastern Shore." Pine trees constitute the major forest industry of Delmarva. Most of the forest tracts in Delmarva are privately owned, with only a small fraction in public ownership.

The Delmarva pines are utilized primarily for poles, pilings and rough construction. Baliko says, "Yes, the situation was urgent." No legal aspects were involved. Politically the situation was important and the Commissioners of the various counties participated in Council and public meetings.

Both loblolly, the most abundant pine species in Delmarva, and Virginia pines were attacked by the insect. Other conifers, even hardwoods in the center of pine stands, were affected, although their numbers were not significant.

The imagery data was passed on to the Council, to timber owners and to the state and federal agencies mentioned above. Some of the officials and owners of the large timber companies accompanied Baliko to Wallops for tours. They were shown what equipment, methods and imagery data were available for public use.

Baliko says that a group of Tidewater foresters from Virginia will soon make a tour of Wallops.

According to Baliko, the esthetics of the forests were impaired by the beetle infestation. More importantly, the plant and animal ecology was altered. With less mast available, it is presumed that the animal population would decrease. Animals like squirrels and birds would be severely affected. With the disappearance of the pines, the character of the forest would change, and the hardwoods--formerly only the under-story--would come into dominance.

Baliko states that his work would have been much easier if Wallops then had the equipment it now has. A densitometer could have scanned the imagery, and print-outs of the infested areas could have been automatically prepared.

When asked to comment in general on the remote sensing operations of the Chesapeake Bay Ecological Program, Baliko said, "The U-2 platform is the one favored by foresters and the forest industry. The scale of the U-2 imagery is proper for our purposes. I don't think that NASA should compete with private firms engaged in similar lines of work."

In his own business, Baliko uses the services of private companies which purvey remotely-sensed data. One of the companies is Bendix Aerospace Systems Division, 3300 Plymouth Road, Ann Arbor, Michigan 48107, Telephone (313) 665-7766.

Baliko is presently under contract to NASA Wallops. The contract involves LANDSAT (formerly ERTS 1), with underflights by U-2 aircraft. Dr. David Oberholtzer is Baliko's contact at Wallops. The project will use techniques for (1) identifying and inventorying the pine trees, and (2) for reducing the errors contained in existing records of pine stand acreages. Right now Baliko is awaiting the arrival of digital data from NASA Goddard.

PRIVATE ORGANIZATIONS cont'd.

The Nature Conservancy--Gerard (Rod) Hennessey.

The Virginia barrier islands lie off the Atlantic Ocean coastlines of the State's Eastern Shore counties of Accomack and Northampton. The islands, dozens in number, range in size from almost nothing to thousands of acres. Some are merely narrow strands of sand, while others are heavily forested. Most are comprised of marshes and dunes.

The barrier islands protect the mainland from destruction by wave and storm. They are ecologically and economically important as the breeding grounds for waterfowl and shorebirds, and fin and shell fish.

Since the late 1960's, ownership of nearly a dozen of the Virginia barrier islands has passed into the hands of The Nature Conservancy. The Conservancy is a national conservation organization devoted to the preservation of ecologically and environmentally significant land. It protects threatened natural areas by purchase, by acceptance of donation and by advance acquisition of land for local, state and federal governments. The Conservancy is a member-governed nonprofit organization incorporated in 1951 in the District of Columbia for scientific and educational purposes. Since its first acquisition in 1954, the Conservancy has acquired 750,000 acres under 1300 separate projects.

The Conservancy became involved with the Virginia barrier islands in the late 1960's when several schemes were publicized for the residential development of the islands. Plans announced for the development of Smith and Kent Islands produced special alarm in conservation circles.

In the cause of preserving the islands (technically, a few are not barrier islands) as a vital portion of the coastal ecosystem functioning in its

TNC cont'd.

natural state, the Conservancy began acquiring various components of the barrier island group. The most recent purchase came in November, 1974, and brought the total of land acquisitions to 33,000 acres. The Conservancy refers to its holdings as the Virginia Coast Reserve. (The Conservancy apparently entertains some thoughts of obtaining easements on the mainland peninsula coast by buying rights from private owners.)

Some of the barrier islands contain virgin pine forests, good water and grazing land; others are comprised solely of marsh and tidal land. All of the islands were formerly in private ownership; some were owned by a single individual, while others had been bought and subdivided by real estate companies.

At the beginning of the Conservancy's acquisitions, most of the land holdings were not for sale. The situation has changed. Most owners are now willing to sell. Two small islands, Holly and Raccoon, with a total of about 200 acres, containing a few residences supported by power generators and boat transportation, are now for sale. Representatives of The Nature Conservancy are of the opinion that the barrier islands are unsuited for development in the conventional sense, because neither roads nor bridges exist, and the cost of providing the amenities of normal life are prohibitively expensive.

The barrier islands are in a constant state of geomorphic flux. Since the formation of the barrier group 5000 years ago, many islands have vanished and many have come into existence. The shape and size of an island changes from year to year in accordance with the action of weather and ocean. State and federal governments refuse any longer to grant the massive funding required for protecting the coastline from erosion.

Conservancy representatives at the Virginia Coast Reserve profess not to

TNC cont'd.

know the true value of their barrier islands acquisitions. Reluctantly, they furnished the interviewer with a "ballpark figure" of \$1 million to \$20 million. They report that good farmland on the Virginia peninsula nearby sells for \$1000 an acre. For its purchases of salt marshland islands, the Conservancy has developed a "fair market price" of \$61 an acre. This is a real estate agent's figure, and contrasts markedly with the ecological value of \$80,000 per acre set by ecologist Eugene P. Odum.

The Conservancy prefers not to be drawn into an exercise in making monetary assessments. It operates by the philosophy that "the protection of the original natural world will eventually be of essential value to Man's well-being, and that the rewards cannot be foreseen."

Gerard (Rod) Hennesey is the Director of the Virginia Coast Reserve. An official of The Nature Conservancy, he maintains a home and office in a rented residence in the small community of Wachapreague, Virginia. Hennesey says that the Reserve's largest holding is Parramore Island, a 7000-acre tract which is recognized as the "crown jewel" of the Virginia barrier islands. Parramore is invested with a prime timber forest, but the Conservancy anticipates no harvesting of the woody resources.

In ruminating about the Reserve's future, Hennesey foresees a policy providing for as much non-destructive usage as possible. Decisions about the management of the Reserve cannot be made before the sensitive uses are first cataloged. It is likely that certain sectors of the Reserve will be apportioned to hunting, fishing and bathing. But elaborate facilities are planned nowhere, and the Conservancy intends to "keep a sharp eye open" to forestall any destruction of ecologically significant areas.

Hennesey also expects the Reserve to become a study ground for scientific research, and an open-air laboratory for environmental education for schools,

TNC cont'd.

scout groups and other organizations.

When questioned about the future ownership of the Reserve, Hennesey points out that ordinarily the Conservancy re-sells its acquisitions to government agencies, universities and to private conservation organizations. The Conservancy asks reimbursement for the price it paid, plus expenses and overhead.

Hennesey says that at present the future disposition of the Reserve is not known. The Conservancy may transfer ownership to the State of Virginia or it may retain possession itself, utilizing the Reserve as a "show case," a prototype for the management of marine and estuarine sanctuaries.

To help decide how the Reserve will be managed, the Conservancy "has committed itself to conducting an ecosystem and resource management study of the entire barrier island chain." The 18-month study will have the full participation and direction of an ecologist (Mr. Hennesey) from the Conservancy's national office.

Director Hennesey in turn has contracted a six-month study within the larger study. He has engaged Cheryl Ann McCaffrey, a graduate student in the Botany Department of the University of Massachusetts under Dr. Paul Godfrey, to pursue a four-part Vegetation Analysis of the Virginia Coast Reserve and to submit a report of her findings by July, 1975.

The format of the McCaffrey report will be as follows:

1. Base maps delineating and identifying the vegetation and indicating significant biological areas and possible recreational sites by use of United States Geological Survey photographic maps and photographs and imagery taken by the NASA Wallops Flight Center.

TNC cont'd.

2. Textual description containing (a) a listing of plant and animal communities, (b) variations within community types, (c) instances where natural changes affect the ecology, (d) fragile communities and rare and unusual species, (e) specific management recommendations for various regions, (f) an analysis of the proper use of NASA data and (g) an inventory of native and exotic plants.

3. Herbarium. A collection of specimens of the Reserve's plant species.

4. A photographic documentation of the study's findings.

The use of NASA's services for the Conservancy's resource management study was first suggested by Roy Deitchman, a student intern at The Nature Conservancy. (Mr. Deitchman is no longer associated with the organization.)

Hennesey's appointment as Director of the Reserve may have owed to the fact that he had previous experience with the interpretation of aerial photography. His Master's Degree thesis involved the use of low-altitude, black-and-white aerial photography.

The McCaffrey study will utilize color infrared photography taken by NASA Wallops aircraft in July, 1974, and on file at the Flight Center's imagery repository. No additional flights will be requested.

USGS photographic maps in black-and-white taken from 10,000 feet in 1973 are available, but they will be utilized in a subordinate role by the McCaffrey study. Analysis will be conducted primarily through Wallops imagery in the infrared part of the electromagnetic spectrum which vividly portrays vegetation types. NASA's color infrared imagery can readily distinguish plant communities like the pine-cedar association and the dune grass complex.

TNC cont'd.

Both the larger study and the McCaffrey study are being financed through an endowment by the Mary Flagler Cary Charitable Trust to the Conservancy. Hennesey used color infrared Imagery from Wallops to Explain to Trust Officials the Need for Management Studies of the Reserve.

Hennesey told the interviewer that the Wallops imagery will receive ancillary use as materials for Ms. McCaffrey's Master's Degree thesis, and by her Department Head, Dr. Paul Godfrey.

Asked to comment on NASA data and the Chesapeake Bay Ecological Program, Hennesey said, "The data and imagery are a great thing to have available."

When asked to suggest possible improvements of NASA's services, Hennesey replied, "We would be interested in a cross-referenced index of NASA cooperative-study programs by subject and by investigator. We could consult the index to obtain sources of additional information and advice. We'd like to be able to meet all the experts at Wallops and elsewhere."

As an example of the expertise of Wallops personnel, Hennesey cited physicist Charles Vaughn who is endeavoring to develop spectral signatures of wildlife habitat associations.

Hennesey was invited to comment on the Virginia Coast Reserve's relations with the public. He said:

"At first there was a certain amount of animosity. The local people thought the Nature Conservancy was a government agency. Attitudes have changed now, although some resentment among real estate agents still exists.

"We have kept the public informed (of our transactions) through the newspapers. The tales circulated about our posting of 'No Trespassing' signs are untrue. We never erected any signs. It is true that we do not want traffic on certain fragile communities until we can carry out our studies.

TNC cont'd.

"Some of the local residents may look on our operations with disfavor because the barrier islands have traditionally been treated as part of the public domain.

"Some additional resentment may have arisen through the Conservancy's acquisitions by way of quit claim titles."

James MacFarland is another Nature Conservancy representative working with Hennessey at the Virginia Coast Reserve. Mr. MacFarland participated in the interview at Wachapreague.

PRIVATE ORGANIZATIONS cont'd.

Ecology and Environment, Incorporated--Frank B. Silvestro.

Frank B. Silvestro is vice president and a founder of Ecology and Environment, Incorporated, a consultant firm organized in 1969. The corporation performs research, provides data and makes recommendations on ecological and environmental subjects. Its services are retained by public agencies and private companies.

Ecology and Environment, Incorporated, engages in a broad range of studies. It produces environmental impact statements for industries. It does environmental planning for private companies. It maintains scientific laboratories for developing methods and equipment for correcting and improving sewage treatment systems. It has conducted research on the handling and disposal of solid waste.

Silvestro emphasizes that Ecology and Environment, Incorporated, is more than an engineering company. He stresses the fact that the corporation is one of the few firms equipped to assess socio-economic conditions, and, in fact, was once retained to evaluate and report on the socio-economic impact that a large strip mine industry has on a small community.

Ecology and Environment, Incorporated, employs a professional staff of more than 100 persons. The corporation's main office is located in Buffalo, New York. Branch offices are in Washington, Billings, Houston, Anchorage and Tokyo.

Frank Silvestro holds a Master's Degree in bio-physics. However, his role with the corporation is one of technical management. He has spent much of the past two years in Alaska where the corporation holds a Department of the Interior contract for surveillance of the impact of the trans-Alaskan oil

Ecology and Environment, Inc. cont'd.

pipeline upon the environment. The corporation is monitoring erosion, sedimentation, wildlife and other aspects of the environment.

Silvestro first became involved in the realm of remote sensing while engaged in studies of vegetative pathologies as part of the program of advanced research projects for Cornell Laboratories during the 1960's. He has worked in Thailand, Malaysia and elsewhere in tropical Asia. Much of his research was concerned with the development of visual and non-visual imaging systems for the Department of Defense. Silvestro told the interviewer of working with a camera worth \$30,000.

Silvestro disclaims any personal expertise in plant pathology. His main contribution to the research projects was as a director-coordinator. His job was to integrate the work of the various scientific disciplines.

Silvestro's career overseas during the 1960's focused on studies of tropical vegetation. The objective of the studies was to detect plant stress at an early stage. Silvestro says that the investigators successfully developed techniques which enabled them to recognize even the most minimal degradation of the forest jungles of Thailand.

When asked by the interviewer to explain the basic purpose of the tropical research, Silvestro answered that the studies were of fundamental value to the management of the vegetative resources.

Urban Vegetation Stress Studies: Silvestro's use of the remote sensing services of the Chesapeake Bay Ecological Program at NASA Wallops came about through a contract between Ecology and Environment, Incorporated, and the National Park Service in 1971 or 1972. Under the contract, Silvestro's firm was to instruct NPS personnel in the techniques of conducting research on vegetative stress. A small area of Washington, D. C., was selected as the test site. The area lay in the vicinity of the Reflecting Pool, the Washington

Ecology and Environment, Inc. cont'd.

Monument and the Tidal Basin, a locality abundant with shade and ornamental trees.

NASA Wallops performed a series of overflights of the area to acquire imagery. Examination of the vegetation, mainly trees, was done via black-and-white infrared photography. Analysis of the imagery was carried out at the Chesapeake Bay Ecological Program Center. The Center's microdensitometry equipment was utilized intensively. The computer laboratory at Wallops processed the data.

The contract of Ecology and Environment, Inc., with the National Park Service was a small one. Silvestro recalls the contract as being of the order of \$2000, and he believes that the corporation may actually have spent more money than it earned under the terms of the contract. Nevertheless, the corporation was pleased with the opportunity to assist the National Park Service in its operations and to have promoted the cause of plant pathology research. Silvestro declares that the project was a "success."

Dutch Elm Disease Research: An outgrowth of the test study was a proposal by Dr. Gary P. Clemons, a staff scientist of the National Park Service, to study via remote sensing the occurrence of Dutch Elm Disease among the trees of the District of Columbia. The study was carried out under the direction of Dr. Richard Hammerschlag, Clemons' successor at NPS. (Clemons had departed the National Park Service to accept employment with Ecology and Environment, Inc., and is now working in Alaska.)

Tree Inoculation Research: Silvestro and the corporation have engaged in plant pathology research with tree inoculation. Some of the research has been addressed to the spread of Dutch Elm Disease. The research has been conducted both in the field and in the laboratory.

In inoculation experiments, a tree is infected with a disease by injections

Ecology and Environment, Inc. cont'd.

into the sapwood. Laboratory work indicates that a period of two weeks is required for the disease to be transported through the circulatory system and cause the tree to display signs of stress.

Although tree inoculation offers considerable promise for combatting the spread of disease by boring insects, plant pathologists remain gloomy because of science's inability to prevent the spread of disease through contact of root systems of neighboring plants.

To exemplify the economic importance of tree disease studies, Silvestro cited the city of Buffalo where 5000 elms perish each year and must be felled and removed. In the period 1951-1971, 60,000 of the city's 120,000 elms were cut down. The sanitation program cost \$606,000 in 1970 alone. The alternative to the program is to lose every elm in the city.

Buffalo city forester, Edwin Drabeck, has informed the city's private owners that they must expect to pay trained arborists as much as \$75 a tree for fungicide treatments of diseased elms.

The American Shade Tree Association has set a value of \$1500 on the worth of each shade tree. Silvestro feels that even this figure may be an under-estimation.

Frank Silvestro has established himself as a leader in the field of remotely-sensed detection of stressed vegetation. He regularly publishes the results of his investigations. His articles have appeared in photogrammetry journals. In June, 1969, he was awarded the prize of the American Society of Photogrammetry for the year's best article on photographic interpretation.

The following quotations were culled from Silvestro's telephone conversation with the interviewer, Dale Fuller:

"Despite all our work--even using remote sensing--we haven't been

Ecology and Environment, Inc. cont'd.

successful in the pre-visual detection of plant stress.

"You have invited my criticisms. Here's one. The ERTS sensors were a step backward in time. One of the designers of the sensing system--a man who should have known everything there was to know about the subject--actually came to me and asked what bands I thought should be used on the satellite.

"It's my opinion that many of the bands are totally non-productive. In fact, the band that was selected for chlorophyll-detection was a very poor choice.

"I buy imagery--of Delmarva and other places--not for any specific purpose, but just for my own interest.

"Some investigators have had trouble adjusting themselves to NASA's way of operations. I haven't. Sometimes, though, I find I have to buck the 'system.'

"The remote sensing capabilities of NASA have not always been used to best advantage. For instance, the research done by satellite by a certain scientist from a west coast university was repetitious. He kept doing the same sort of thing over and over.

"Much of the research with remote sensing has been limited in scope. My recommendation is that the NASA research program be broadened.

"I feel strongly about the remote sensing program at NASA Wallops. The program's continuation is a worthwhile question. I would be willing to come down there--to Washington or elsewhere--to testify on the matter. I'm a dispassionate observer. I have no private motive. I just want to see science advance.

"I'm hesitant to say so, but I fear that some of the remote sensing research has been 'quasi-science.' Maybe the program should be put on a more scientifically-sound basis."

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